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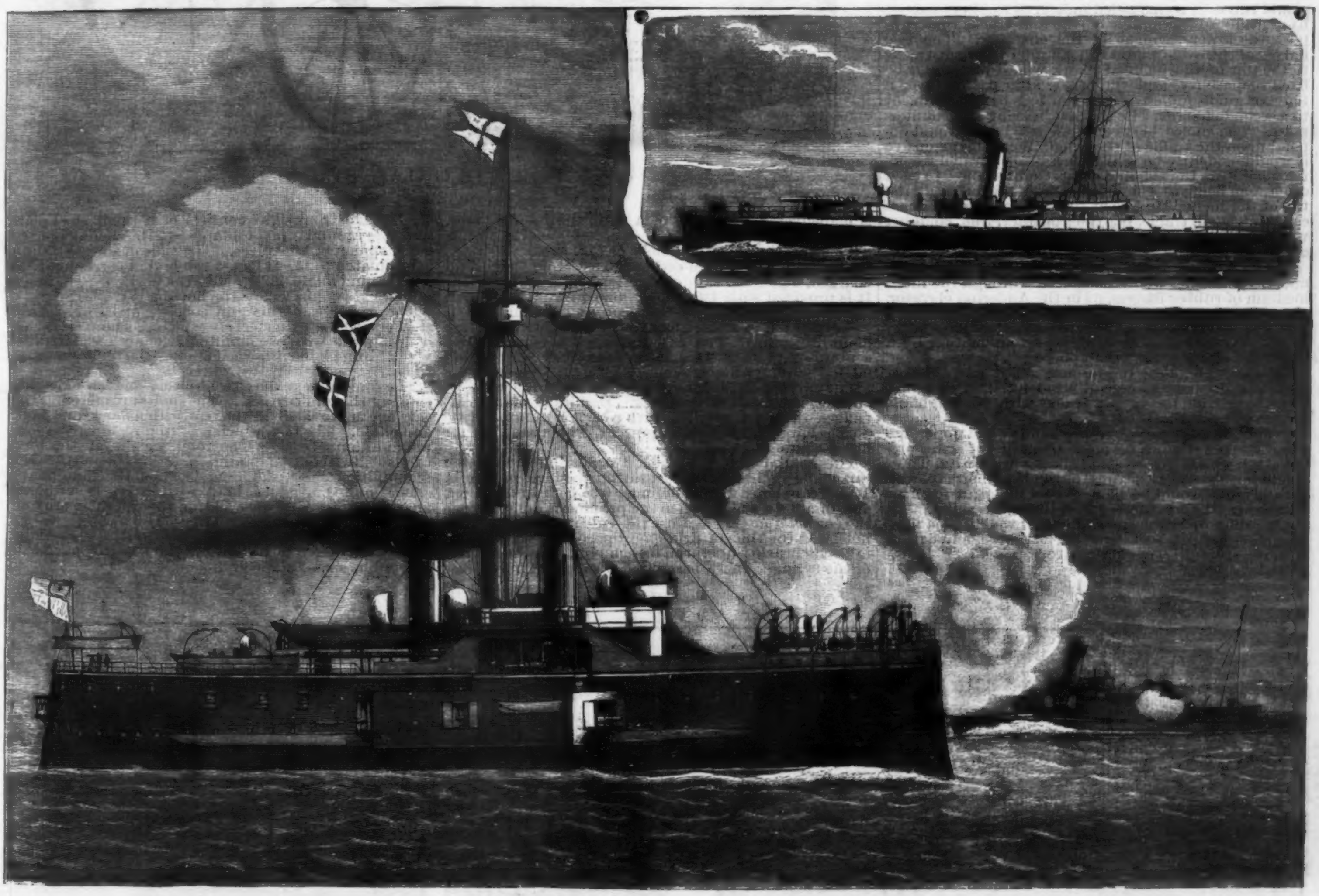
GERMAN MEN OF WAR.

In the annexed cut, taken from the *Illustrirte Zeitung*, the armored ship Oldenburg, the armored gunboat Brummer, and the torpedo boat Jaeger, of the German Navy, are shown. These vessels, which are the latest additions to the navy, represent three special types. The armored ships, formerly known as armored corvettes, are to be used for defending the coasts of the North and Baltic seas, and, as it is not intended to send them to distant stations, they are provided with look-out masts only, but not with booms, sails, etc. They have a few very large guns, a strong lance spur, and a tube for firing torpedoes at the bow. The Oldenburg is to be used in the Baltic Sea only, and her armament is not quite as heavy as that of the others. Besides the broadside battery, she has strong guns mounted to fire forward and aft, which is of great importance in attack and defense. The armament consists of six nine inch guns, two boat and landing guns, four torpedo guns, and three revolving cannons. It is heavily armored, and, at the same time, it can attain great speed and can be maneuvered very easily and very rapidly.

The armored gun boats, which are to be used on the coasts of the North and Baltic seas, and in the numerous channels, bays, etc., of these coasts, are so constructed as to draw very little water, can attain a medium speed, and can be easily propelled and maneuvered. They have very heavy guns, and can even venture to attack a large armored ship near the coast in shallow water, where the large armored vessels cannot move advantageously. They are provided with heavy spur, and the guns are located about nine feet above the water, so that the seas breaking over the vessel would not interfere with the handling of the gun.

The torpedo boat Jaeger was completed in 1883. Twelve of these torpedo boats have been completed, and twenty-four are now being built. They are not long, and are of light draught, but have very powerful engines, by which great speed can be attained. Each boat has two devices for firing torpedoes, and two revolving cannons. They have no masts or sails, and can carry sufficient coal to run 1,000 knots at the rate of 10 knots an hour.



RECENT ADDITIONS TO THE GERMAN NAVY.—THE ARMORED SHIP OLDENBURG, THE ARMORED GUNBOAT BRUMMER, AND THE TORPEDO BOAT JAEGER.

NEW SYSTEM OF INCLINED PLANE FOR BOATS.

A prominent subject that has been under study for some years past is that of elevators and of inclined planes for boats. The efforts that are being everywhere made to find a practical and advantageous substitute for lock chambers are being watched with the greatest interest in all countries by engineers who are in charge of internal navigation service, and by all partisans of progress. This antique and primitive device is still almost solely and universally employed for passing boats from one level to another.

The devices that have been proposed as substitutes may be divided into two categories, viz., those in which the motion is vertical, and which are usually styled elevators, and those in which it occurs in a more or less inclined direction. These latter are called inclined planes, although the surface that directs the motion is not necessarily in the same plane throughout its entire extent.

Mr. Hirsch, in a work published in 1881, describes four applications based upon the inclined plane system; one on the Morris Canal (United States), one on the Oberland Canal (Prussia), one on the Markland Canal, and one on the Georgetown Canal (United States).

Of these, only the Georgetown one has been operated for a certain length of time with loaded and floating boats. The three others serve merely for the carriage of empty boats (Markland Canal), or for boats out of water (Morris and Oberland canals). Besides, the boats are of small dimensions, their maximum capacity being as follows:

Inclined plane of Morris Canal..........	70 T.
" " " Oberland Canal.......	70 "
" " " Markland Canal.......	60 "
" " " Georgetown Canal....	115 "

On the projected canal from the Escant to the Meuse (France), there exists at the city of Cateau a difference of level of 156 feet, that has to be compensated for over the short distance of three miles, and here the boats to be maneuvered carry a load of 300 tons. It would be dangerous to allow these boats to cease to float, for they are usually built of very light material, and many are still afloat that exhibit marks of age and wear. For this reason, Mr. Peslin, to whom was confided the study of this new canal, was led to work out a new system of inclined plane, which he has recently described in the *Annales des Ponts et Chaussees.*

This system consists essentially of a movable iron plate chamber of dimensions analogous to that of the Fontinettes elevator. With its wheels, gates, and all its accessories, this will weigh 190 tons empty. It will be capable of holding a boat 126 feet in length, 16·5 feet in width, and of 6 feet draught, weighing when empty from 40 to 50 tons, and carrying 300 tons of merchandise. It will be filled with a mass of water of from 60 to 70 tons, in which the boat will float; so that the total weight to be set in motion will amount to about 600 tons. The calculations have been based upon this figure, but it may be seen that it will be very easy to increase the weight of the apparatus if deeper water be desired. The weight may, without inconvenience, be raised to 700 or 800 tons. This weight is nearly that of a train made up of forty cars, each loaded with 10 tons of coal and hauled by a 60-ton engine. Now, we see trains like this running daily at a speed of from twelve to fifteen miles an hour on the tracks of the Railway of the North, which are composed of rails weighing twenty pounds to the running foot and of ties spaced two and a half feet apart. In these trains the driving axle of the engine carries normally 13, 14, and sometimes 15 tons, without the rails or rims showing any extraordinary strain.

What must be done to assimilate the movable chamber to the train just mentioned? It must be divided into a certain number of parts, each of which may be moved slightly with respect to those that touch it, as with cars, buffer against buffer, so that the wheels which carry every part of the chamber may accurately follow all the horizontal and vertical inflections of the rails over which they run. The project supposes the total weight to be 600 tons, and the chamber to be divided into five parts. Under such circumstances each part will weigh 120 tons, and, in plan, will have the form of a rectangle 26 feet in length by from 20 to 23 in width. In order to make such parts resemble a car, says Mr. Peslin, we shall distribute the weight of each over four bearing points, and, as each of these latter

will have 30 tons to support, it will require four wheels in order to have each of them carry but 7½ tons. It was in this way that the arrangement shown in the accompanying engraving was reached. Each of the five parts of which the chamber consists is formed of an iron frame of variable height that supports the iron plate receptacle designed to receive the water and boat.

The sole object of the frame is to distribute the entire weight of the whole equally over four small trucks analogous to those used for supporting the front of the new express engines of the Company of the North, and the ends of the long passenger cars used upon American railroads. The four trucks that support the same part of the chamber are firmly connected with each other and run over parallel rails that differ from the tracks of ordinary railroads only in the space between them, which will be about 3·25 feet.

In short, by the means just indicated, it is believed that a problem that has exercised the sagacity of many constructors has been fully solved.

For forming a tight joint between each element of the chamber, Mr. Peslin proposes to use rubber 8 in. in width by 2 in. thickness. As traction is to be effected by a cable fixed to the lower segment of the chamber, all the segments will be pressed against each other by the components of their weights according to the inclination of the track, and this, in Mr. Peslin's opinion, will suffice, seeing the enormous weight in play, to secure tightness in the joint, while at the same time allowing its mobility and elasticity to be preserved.

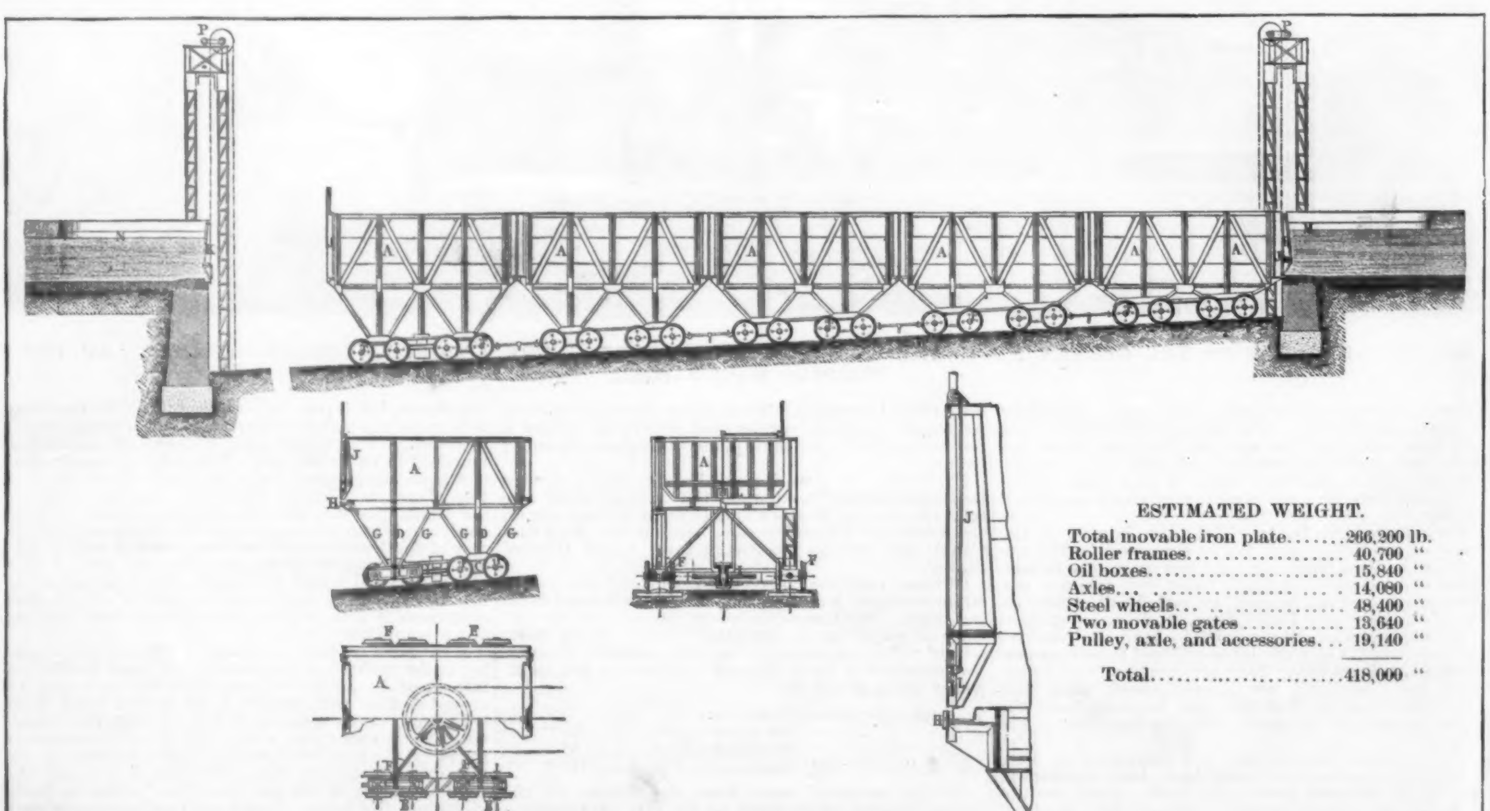
As regards the inclination of the track, it is proposed to have that 1 to 20. With such an inclination the stress to be exerted upon the chamber in order to set it in motion would be 120 pounds to the ton, or 66,600 pounds to the 600 tons. Such a stress can be easily exerted by means of a flat steel cable, such as is now manufactured for use in coal mines. This cable would run over a channeled pulley, 20 feet in diameter, fixed firmly to the middle of the four tracks that support the lower segment of the chamber. The two halves of the cable would run parallel between tracks to the top of the inclined plane, where one would be fixed to masonry, and the other, after passing over a ten-foot guide pulley, would run to a ballast train, or to a second chamber like the first, serving as a counterpoise. The choice between these two latter would depend upon the traffic of the canal. Were this extensive it would evidently be well to install on parallel tracks two chambers that should act as counterpoises to each other, one being at the bottom and the other at the top of the inclined plane at the same moment. For a canal of small traffic, on the contrary, the chamber would be balanced by an earth or ballast train running over a track in the vicinity.

The junction of the movable chamber and the upper and lower reaches would be effected through the intermedium of rubber flanges, as in the Anderton elevator, the tightening, were any necessary, being done by a small press actuated by an accumulator. The latter would be charged by a turbine set in motion by a slight fall of water from the upper race.

In order to regulate the running speed, and to effect a prompt stoppage in case of accident, Mr. Peslin proposes to provide the twenty trucks with Westinghouse air brakes.

Communication between the chamber and upper and lower reaches would be made by means of gates provided with paddle-valves and sliding in grooves. These would be modeled after those of the Fontinettes elevator, and they would be maneuvered by means of fixed cranes placed upon the heads of the two reaches.

According to calculations, the total weight of a movable chamber 135 feet long, 20 feet wide, and 8 deep, with its accessories of every nature, would be 418,000 pounds.



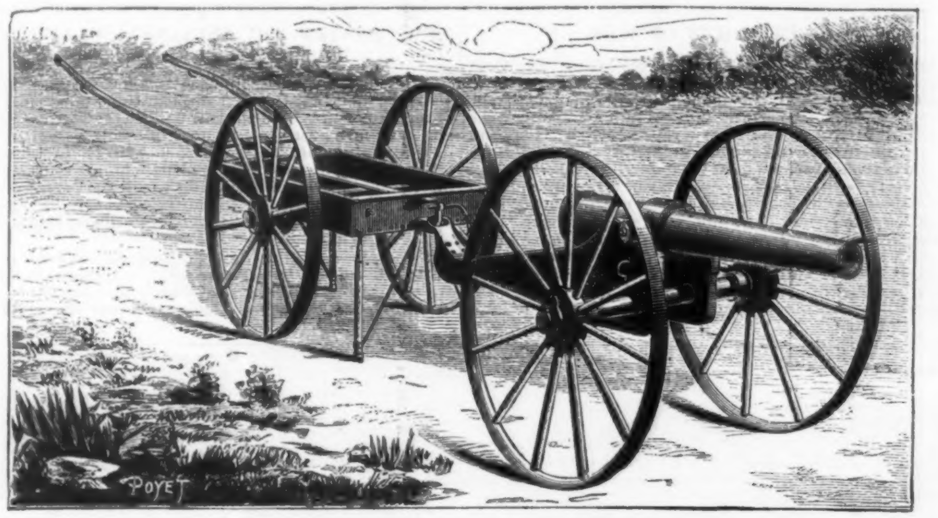
ESTIMATED WEIGHT.	
Total movable iron plate	266,200 lb.
Roller frames	40,700 "
Oil boxes	15,840 "
Axles	14,080 "
Steel wheels	48,400 "
Two movable gates	13,640 "
Pulley, axle, and accessories	19,140 "
Total	418,000 "

INCLINED PLANE FOR BOATS.

A FRENCH GUN FOR COLONIAL SERVICE.

THE accompanying engraving represents a 2⅛ inch gun specially and solely designed for use in the operation of landing. This piece, which weighs 210 pounds, is but 43 inches in length. Its bore is provided with 26 parabolic grooves, whose final inclination is eight degrees upon the axis. The breech is closed by a screw, and the latter is held in the same manner as in ordinary campaign guns. The breech piece is a sort of Broadwell fixed ring of copper, of dimensions such that its edges exactly fit the recess prepared for it.

The firing is effected through a central aperture, as in all naval guns, that is to say, by what is called the "hammer" system; only, instead of being actuated by a spring and pulled down by traction, the hammer is kept cocked by means of a trigger. When this latter is maneuvered by means of a cord, the hammer falls, being thrust by a spring.



GUN FOR COLONIAL SERVICE.

This gun throws either shells or case shot.

The shell, which is of ordinary cast iron, weighs, all charged, 6 pounds. Its charge is 6 ounces of powder. It is provided with two collars, one in front of copper, and another behind of cast iron. The bursting is effected through a fuse analogous to the percussion fuse of all projectiles. The case-shot consists of a zinc box containing 96 hard lead balls, connected by pouring melted sulphur around them. It weighs 6⅛ pounds.

The charge of the cannon, which is 12 ounces of C_2 powder, is contained in a bag. Besides 12 ounce cartridges, the gun is supplied with a certain number of 4¾ ounce charges of the same powder, which are used for firing a plunging shot.

The charge is lighted with a central-fire percussion cap made of brass and measuring one inch in length. These caps consist of a cylinder 0·35 inch in diameter, and of a head which, when the priming is done, arrests the cap by abutting against the entrance of the touch-hole. At the time of firing, on the contrary, this head takes its bearing upon the breech bolt. In the interior of the cylinder there is screwed a nipple of hard brass capped with a capsule primed with fulminate of mercury. In addition, a small charge of sporting powder is introduced. A disk of paper varnished with gum shellac prevents the immediate contact of the nipple with the fulminate; thin disks of paper are interposed between the nipple and the powder; and finally, the latter is held by a piece of wax, the nipple is screwed in such a way that it comes into contact with the bottom of its receptacle. Here the thickness of the metal that forms the central part of the head of the cap is only 0·04 inch. This is the part that receives and transmits the shock of the hammer.

The initial velocity of the projectiles thrown by this cannon is 113,488 feet, supposing a normal charge of 12 ounces to be used. In case of a charge of 4¾ ounces, the velocity is reduced to 61,336 feet.

The breech-sight, which is inclined to the right, is of steel. The front-sight consists of a small steel plate movable around a pivot adapted to the shoulder of the left trunnion of the piece. The slide of the back-sight is graduated to 15,744 feet, a range that corresponds to a maximum angle of 25° above the horizon. The maximum angle of aim below the horizon is 17°.

The carriage of this gun consists of two cheeks of steel connected by a steel cross-piece. The axle is made of iron plate with wood filling. The wheels are likewise of iron plate with wood filling. The total weight of the carriage, with its two wheels, is only 272 pounds.

The fore-carriage has two wheels and an axle like those of the gun-carriage. The shafts are of iron. The carriage is provided at the rear with a hook and bolt, and chain. The box, which is of iron plate, carries four ammunition chests. The total weight of this fore-carriage, without ammunition, is 406 pounds. Each ammunition chest, weighing 136 pounds, contains ten shells and four case-shot, with fourteen ordinary charges of powder. In addition thereto there are four 4½ ounce charges and twenty percussion caps.

When the gun is accompanied with its fore-carriage, it is served by ten men; without the fore-carriage, it requires but six.—*La Nature.*

POINT BRIDGE, PITTSBURG, PA.

WE give an engraving of the Point Bridge over the Monongahela River, at Pittsburg, Pa., built by the American Bridge Company, from the designs of Mr. Edward Hemberle, one of the engineers of the company.

Pittsburg is eminently a city of bridges—necessarily so on account of the three large rivers flowing through her limits. While some of them are of humble pretensions, others will compare favorably with bridges to be found anywhere. The Point Bridge was formally opened on March 31, 1877.

The structure is the first example of a stiffened chain suspension bridge of long span, and differs considerably from others in existence. The chain is designed as a catenary, and takes up all the permanent load of the structure without bringing strains on the stiffening trusses. This object was accomplished by erecting the bridge completely before connecting the ends of the straight top chords to the center joint. The tie rods are provided with turn buckles, and are so adjusted as to be strained under moving loads only. When the bridge is half loaded, the top chord of the trusses on the loaded side is in compression, and of the unloaded side in tension. The maximum strains for the different members of the trusses occur under different positions of the moving load.

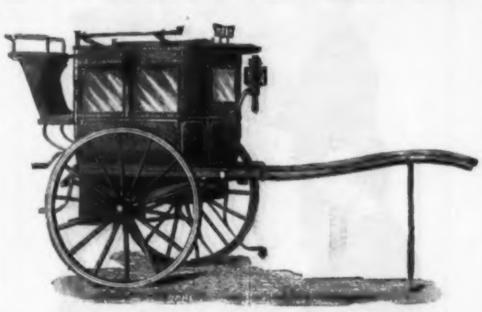
There are lateral and vibration braces between the top chords, and also between the chains, proportioned to take up the strains from wind pressure upon chains and trusses. The floor is 34 feet wide between the stiffening girders, which are 8 feet high, forming the hand rails. The stiffening girders have expansion joints every 100 feet, and are suspended from the chains by flat bars 20 feet apart. At the expansion joints there are struts instead of suspenders, in order to make a rigid connection between the roadway trusses and the chains. Cross girders 3 feet in depth connect the stiffening girders every 20 feet, and support two lines of iron stringers. These stringers and the roadway trusses form the bearers across which are placed the wooden joists for the flooring.

The lateral stiffness of the floor is secured by a double system of tie rods, and the wind pressure is taken up by horizontal steel wire cables, placed under and connected to the floor.

The towers are entirely of wrought iron, except the bases of the columns. The columns are 30 inches square each, are connected by lattice bars, and form the tower. The chains are carried over the top of the tower on wrought iron chairs or saddles, which are movable on rollers to allow for expansion and the elongation of the back chains under strain.

The bridge is proportioned for a moving load of 1,600 lb. per lineal foot, under which, together with the weight of structure, the chains are strained to 12,000 lb. per square inch, sectional area. The suspenders and roadway members are strained only from 8,000 to 10,000 lb. per square inch. The maximum compressive strains in the towers are 9,000 lb. per square inch.

The bridge consists of three spans. The center span is 800 feet and the end spans 145 feet each—the total length from back to back of the anchorage being 1,245 feet. The roadway rises from each end, and at the center of the channel is 83 feet above low water. The saddles on top of the towers, upon which the chains rest, are 180 feet above low water, and the deflection of the chain is 83 feet. The floor is divided by iron hand rails into a 21 foot wagon way and two 6½ foot sidewalks. The piers are built of Baden sandstone laid in



FOUR-SEAT "DEVON" HANSOM CAB.

cement. There are two chains, one on each side of the bridge. The links are formed of from eleven to fourteen bars, 20 feet long and 8 inches by 2 inches to 8 inches by 1 inch in size, and are connected by 6 inch pin bolts, the same bolts also connecting the links.

The material used: Timber in foundations, 4,442 feet, board measure; masonry in anchor walls, 10,868 cubic yards; masonry in piers, 7,507 cubic yards; iron in foundations, 12 tons; wrought iron in superstructure, 2,084 tons; cast iron in superstructure, 52 tons; steel in superstructure, 32 tons; timber in superstructure, 810,000 feet, board measure; number of links in the chains, 1,832.

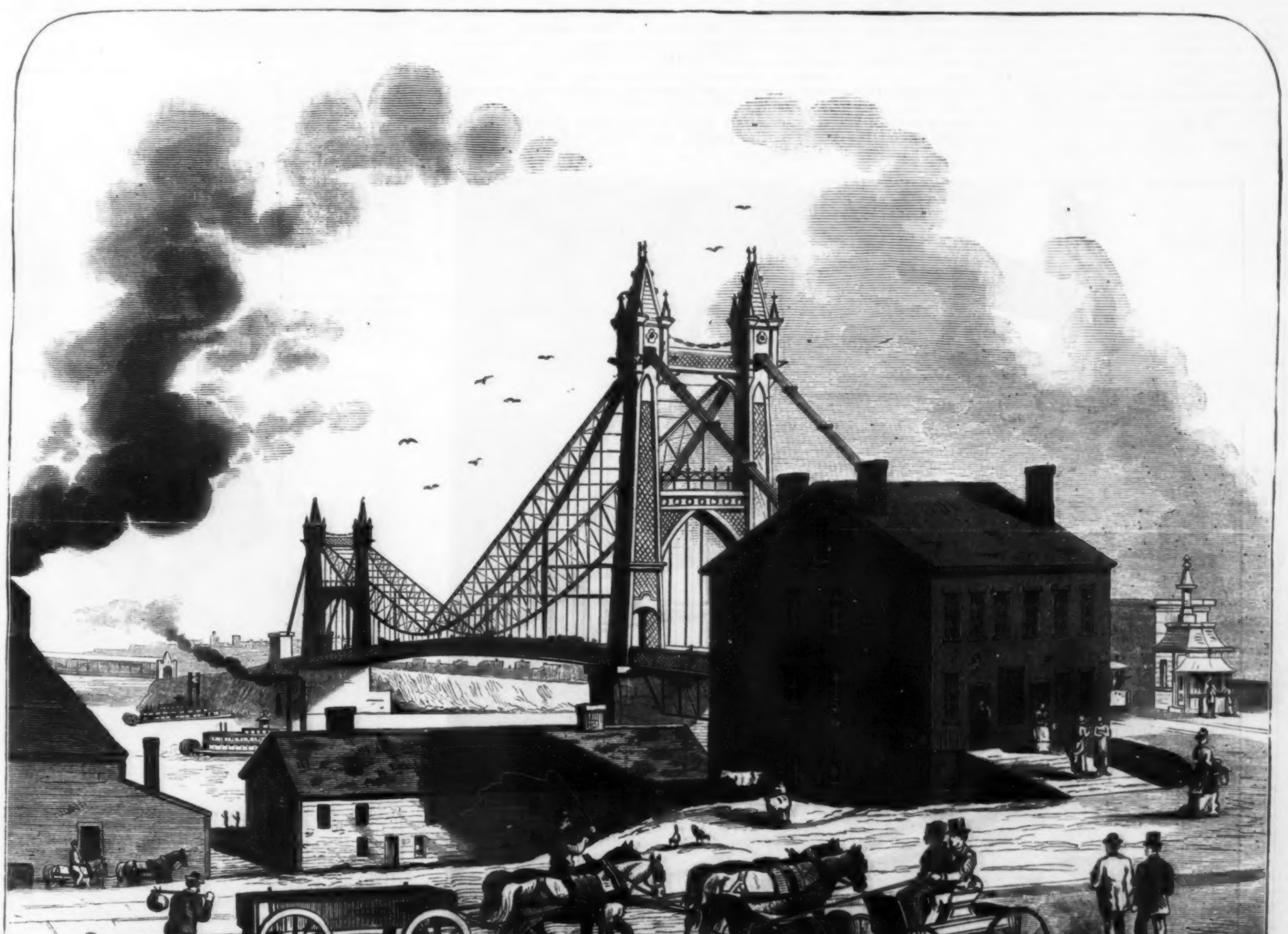
The cost of the bridge was $525,000, and although it was erected by a Chicago company, nearly all the iron work was done by Graff, Bennet & Co., of Pittsburg.

FOUR-SEAT "DEVON" HANSOM CAB.

WHAT would appear to be a great improvement upon the ordinary slow going four-wheeler is to be seen at the Inventions Exhibition on the stand of Messrs. Abbott & Co. of Torridge Works, Bideford, Devon. This is a four-seat hansom, which we illustrate. The points of resemblance to the ordinary hansom are the position of the driver at the rear, looking over roof, high wheels for speed, and long springs for easy riding. The variations from the ordinary hansom are the entrance at back instead of front, two side seats, each carrying two passengers, and a single door opened and closed by driver while in his seat, as well as by passengers. The advantages claimed for this vehicle are numerous, among them being the speed of an ordinary hansom, which is obtained by mounting cab on wheels of the same height, and balancing the body on the wheels so as to remove the weight from the horse's back. The peculiar construction of this cab enables the horse to draw from points of attachment much closer to the axle than usual. The entrance at the rear, behind the wheels, prevents danger from the horse's heels, or sudden forward movement, while passengers are entering; and in the event of horse falling, kicking, etc., after passengers are in the cab, quick and easy exit is safely afforded by the door at the back. The driver opens and closes door while in his seat, without relinquishing his reins; the horse is therefore always under control. Easy riding and absence of noise are obtained by arrangements of construction; also free communication as desired by the passengers through the back window with the driver; who can receive instructions, take fares, give change, etc., all while passengers are in the cab, without leaving his seat. A low, firm, wide step, covered by the door, is always free from splashed mud. Windows at the sides, front, and back allow an uninterrupted view in all directions, or blinds can be drawn as wished. Ventilation without draught is insured by sliding windows at front and rear, either or both of which may be opened more or less as desired. Wet umbrellas are carried in stand on the inside of the door, arranged to prevent contact with passengers, and for drip to escape. At night a powerful single lamp affords outside light as usual, and also lights interior of the cab. As much luggage can be carried on the roof as on an ordinary four-wheeler, and as it is always in front of the driver, and constantly in his view, cannot be lost or stolen without his knowledge. Another point in favor of the cabman is that dishonest passengers cannot leave the cab while in motion, without paying their fares, as the door is immediately below the driver and close to his hand.—*Iron.*

LAGERMAN'S COMPOSING MACHINE.

ALTHOUGH an effort has often been made to substitute machinery for manual labor in the composition and distribution of types, and although several more or less ingenious apparatus have at various times been offered, the problem has never hitherto been solved in a satisfactory and truly practical manner.



THE POINT BRIDGE PITTSBURG. PA.—BUILT BY THE AMERICAN BRIDGE COMPANY.

Mr. Alex. Lagerman, however, now appears to have found a solution of this delicate problem, and the machine that he has invented and just presented to the notice of Parisian printers is a marvel of precision and of ingenious conception.

The machine consists of a frame resting upon four legs, and provided with vertical grooves for the reception of the type channels, A (Figs. 1 and 2). The two pedals, H and H^1, serve to actuate the fly-wheel, G. This latter, through a cord and gear-wheels, drives a small wheel, G^1, that actuates the distributing mechanism. A similar wheel located below, but not shown in the engraving, actuates the composing mechanism. D is an apparatus that is made to advance or recede by hand for distributing the types among the channels of the machine. D^1 is a horizontal bar with rounded depressions, into which three rings affixed to the distributing apparatus can fall one at a time, and thus give the mechanism a fixed and stable position. The distance between the depressions is thrice greater than that between the type channels, and the distance between the rings is so calculated that the type groove of the distributer D (or O of Fig. 2) stops in front of one of the vertical channels of the machine, when the first ring falls into a depression. Upon causing the second ring to fall into the same depression, the distributer stops in front of another of the stationary channels, and so on. The same fall of the ring thus serves for three different channels, the letters of which are shown one above another upon the horizontal piece, D^2. The upper letter designates the proper channel, when the channel to the left is lowered; the middle one refers to the central ring, and the lower letter to the ring to the right. Besides this, the depressions are divided into groups of three, so that the operator can readily and quickly find the proper one. The distance between the rings and the type channels is small, so that the man who distributes can easily read the line while at work. E (Fig. 1) is a similar apparatus, provided with devices for seizing the types in the channels and forming them into lines. In this apparatus the distance between the rings and type channels is greater, so that the compositor can, without obstacle, seize the types in the channels that face the person who is distributing.

E^1 is a cross piece with the same kind of depressions and for the same purpose as D^1. B is the column to be distributed, and C is the galley in which the composed lines are united into a new column. F is a small case designed for types that are so rarely used that they have no need of channels. The shaft of the pulley, G^1, is provided with a ratchet wheel, between the teeth of which there drops a click in such a way as to allow it to make but a single revolution. This motion actuates a crank that depresses the piece, D^2. This latter carries along the channel of the distributer, the lower extremity of which thrusts the types into one or the other of the stationary channels of the machine. While it remains for an instant in this position, a hook affixed to the distributing mechanism is carried to one side, and, through this, the lower type is pushed into one of the channels of the machine. A small slide provided with a spring shoves the types into the line.

The composing mechanism operates exactly after the same manner. Upon engaging a click with the teeth of a continuously revolving wheel, the crank is forced to make a single revolution that lifts the piece, E^2, which carries along the type channel of the distributer, and displaces another piece that pushes to one side the hook attached to the type channel. In this way a type is shoved across the type channel into the line. A small spring slide holds the line during this operation.

Small pieces that adhere by friction to the sides of the channel hold the distributed types at the upper extremities of the first ones, and small weights press them into the lower extremities. When the types begin to

FIG. 1.—NEW COMPOSING MACHINE. (General View.)

give out during composition, the small weights are used for causing the distributed types to descend; and this having been done, the friction piece is removed (thus allowing all the types to come together) and placed at the upper extremity of the channel. After this the composition may proceed again. If it is desired to distribute types without at the same time composing, a certain number of the types are removed with pincers, and placed until needed in a channel serving as a magazine.

K is a small bent lever, which is actuated by the crank of the pedals, and which revolves the wheel, I, by means of clicks. This wheel is designed for raising and lowering, through a crank, a sort of clamp which holds the composed line in place during justification. N is a lever, with roller, for pushing the line out of the clamp into the galley, C.

Automatic justification of the line to a given length is effected, at single manipulation, by placing 3-*m* spaces between the words, and composing the line to the exact length, if that is feasible, or else making it a little too long. Justification is afterward performed as follows: The line in the clamp is lifted, while a small quoin, sliding alongside of it, enters the interstice between the words. A mechanism, being set in motion, pushes out the upper 3-*m* space, and thus diminishes the length of the line by a 3-*m* space. This continues until the line becomes of the length desired. It might happen that the line became too short, if it were diminished by a 3-*m* space. In this case the mechanism interposes 4-*m* spaces in place of the 3-*m* pushed out. After the line is of the length desired, it continues to rise without other substitutions until it arrives opposite the galley, into which it is pushed by a motion of the lever, N. After this the clamp returns to its lower position, where it remains until it receives a new composed line. When the column is of the width of an ordinary page, 4-*m* spaces may almost always be substituted for 3-*m* ones. The variations between the interstices will then be equal to but the difference between $\frac{2}{3}$ and $\frac{1}{4}$ an *m*-quad, thus giving the columns a handsomer appearance than if the width of the interstices varied from $\frac{2}{3}$ to $\frac{1}{4}$.

The apparatus operates as follows: The man who distributes stands to the left of the seated compositor, and, alternately with the latter, revolves the machine. The distributer, seizing a line in the column, B, by means of a device, B^1, places it in the groove of the distributing mechanism. Then, using the three fingers of his right hand, he gently depresses the proper ring into the depression that indicates the letter to be distributed. By this operation the distributing mechanism is given its proper position. The ring at the same time presses against a movable rod situated behind the piece, D^1, and causes the click above mentioned to drop between the teeth of its wheel, so as to distribute the lower type in the mechanism, D.

The composing mechanism operates in the same way. By causing a ring to descend into one or the other of the depressions in the piece, E^1, a type is carried from one of the channels into the line. When the latter is of the proper length, the mechanism, E, is pushed to the right. The spring then throws the line into the clamp, L, which at once begins to rise in order to justify it; and the compositor passes simultaneously to the composition of the following line.—*La Nature.*

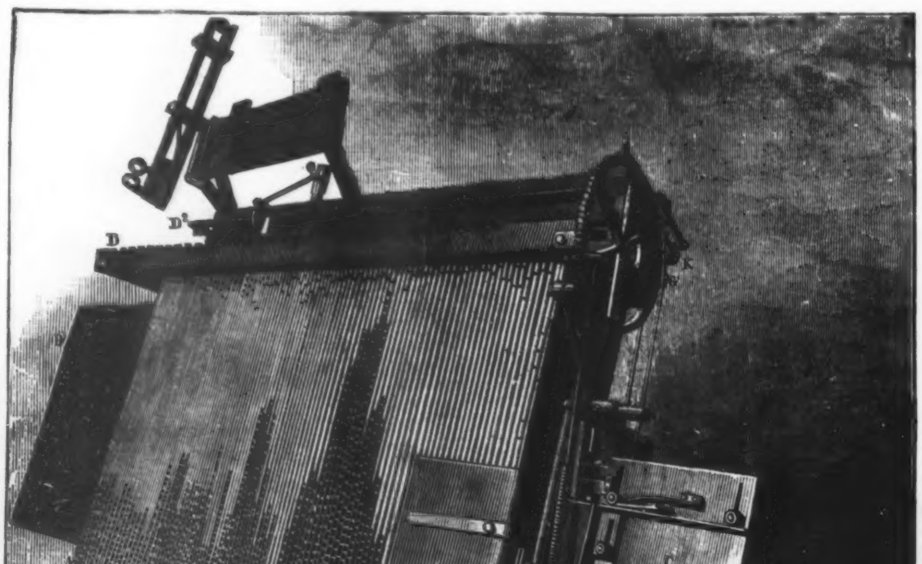


FIG. 2.—LAGERMAN'S NEW COMPOSING MACHINE.

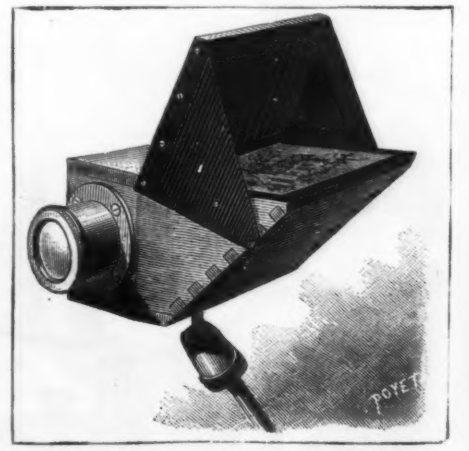
THE MONITOGRAPH.

THE apparatus shown in the accompanying cut is a small improved camera obscura, which may be advantageously used as a substitute for the black convex mirrors that landscape painters sometimes employ. When these latter are used, it is necessary to turn the back on the landscape, and a reversed image is obtained. Again, as the glass is black, so as to prevent double refraction, the scale of tones is not accurate, and furnishes very disadvantageous data to the painter.

With the *monitograph,* which the artist may affix to the easel that supports his picture, we get a reduced image, but one that is very accurate in all its details. The apparatus is placed to the right of the artist, who thus has before his eyes the scene that he wishes to represent, while at the same time the reduced image is not reversed on the ground glass. The luminous intensity of the image is equal, and the tones are true to nature and may be reproduced upon the canvas.

The apparatus is very light (weighing but eight ounces), and is therefore easily carried. It is mounted upon a rod that has a rotary motion, and that terminates beneath in a foot that may be fixed by screws to one of the legs of the easel.

The image forms upon a sheet of ground glass, over



THE MONITOGRAPH. (½ Actual Size.)

which projects a black screen. This latter, which pivots upon an axis, shuts down upon the ground glass when the apparatus is prepared for carriage, and thus reduces the bulk of the whole and prevents the glass from being broken. The image obtained is very small, since it is formed upon a square surface whose sides scarcely exceed two inches; but, as small as it is, it is very sharp and very luminous, and suffices to give the masses in general, and even the smallest details.

The apparatus contains two total reflection prisms, one of which has its principal apex directed upward, and the other one its principal apex directed horizontally. The first reflects the image given by the lenses of the objective horizontally, and the second reflects it vertically to the ground glass.

We have experimented with this apparatus and found it to give good resuls. We noticed that there was no spherical aberration in it, and no refrangibility. We believe that it capable of rendering genuine service to

landscape painters and to staff officers who desire to obtain the general contour of a piece of ground.

The apparatus is the invention of Mr. Marius Mallen, and is constructed by the well known optician, Mr. F. L. Chevalier, of Paris.—*La Nature.*

THE JOHNSON FILTER.

THE filter represented herewith is extensively used in England, and obtained one of the principal prizes at the last Hygienic Exhibition in London.

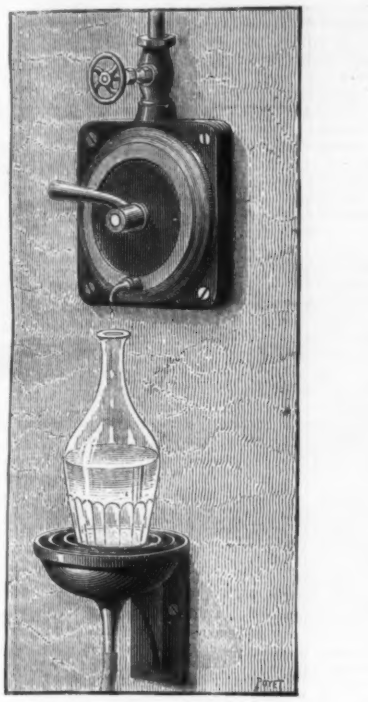


FIG. 1.—THE JOHNSON FILTER.

This filter is both a mechanical and a chemical one, and it is applicable to both domestic and industrial uses. Fig. 1 shows the domestic style, and Fig. 2 gives the internal arrangement of it. The water enters through the pipe shown at the upper part of the engraving, traverses a disk of prepared carbonized paper, B, and reaches a metallic plate, D, from whence it flows off at E. This plate, D, is put in place by means of a screw, F. The disk of filtering paper may be changed with the utmost ease, and the operation may be performed by the most inexperienced domestic. As the entire apparatus is of iron, there is no danger of breakage. The domestic style shown herewith is the smallest size oned. It is constructed in two other styles in which the filtering disks are superposed, so that several of them operate at one and the same time, and thus give a much larger quantity of filtered water within the same period. By thus superposing the filtering parts, Mr. Johnson, the inventor, has been enabled to construct a large industrial model that is much used in breweries, and that is capable of furnishing more than 130,000 gallons of filtered water per day.

In the small apparatus the filtering material is a special paper composed solely of purified cotton fibers, and boneblack freed from all phosphates. In the large

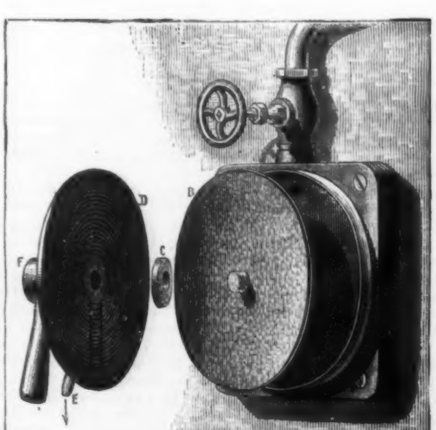


FIG. 2.—DETAILS OF THE FILTER.

filters, which resemble barm presses and are managed in the some way, paper is used in conjunction with specially prepared cloth.—*La Nature.*

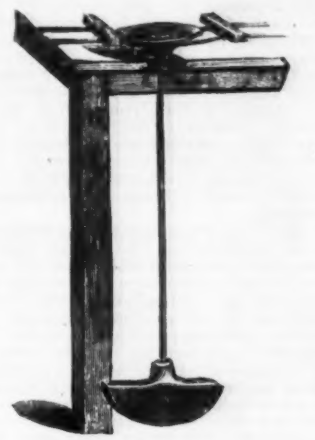
A ROCKING APPARATUS FOR USE IN DEVELOPING DRY PLATES.

By Dr. J. M. EDER.

IN developing gelatine-bromide plates, the vessel containing the developer should be kept in motion, particularly when the amount of developer is small.

Automatic rocking apparatus make the temporary absence of the operator practicable, and hence may be of value, not only in large establishments, but also for amateurs.

I have therefore no hesitation in calling attention to an arrangement made by Herr Braun, of Berlin, and which was much appreciated by the visitors to the Frankfort Exhibition; and as Herr Braun was good enough to send one to Vienna, I had an opportunity of exhibiting it at the general meeting of the Photographic Society in this city. The apparatus is, as the figure indicates, screwed upon a table, and it consists of an iron plate having two V-pieces, in which work the knife-edges of the pendulum. Over these knife-edges is a small round platform, upon which the dish stands, and there are steadying pieces, which slide on iron rods, as shown in the figure. When once the



heavy iron pendulum is set in motion, it remains swinging for a long time.—*Photo. News.*

OXALATE OF POTASH DEVELOPER.

THE following oxalate developer is said to keep well, and was proposed by Mr. Archer Clarke at a recent meeting of the London and Provincial Photographic Association:

No. 1.

Citric acid	1	ounce.
Citrate of ammonium	1	"
Chloride of ammonium	1	drachm.
Bromide of ammonium	1½	drachms.
Oxalate of potash	10	ounces.
Water	50	"

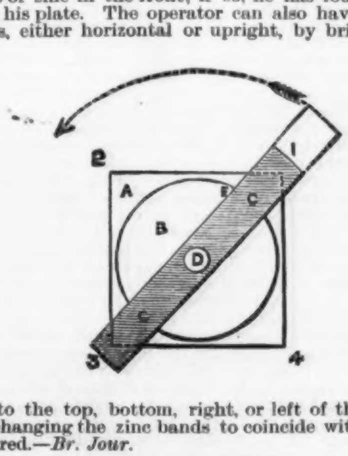
No. 2.

Protosulphate of iron	3 oz. and 160 grs.
Citric acid	1 ounce.
Water	50 ounces.

Mix in equal proportions.

NEW TOURIST CAMERA.

M. BALAGNY exhibited a new tourist camera manufactured by M. Ruckert. This camera is constructed more like an English one, having a square bellows, which is very rarely to be seen in France; but it is on the front of the camera that a new dodge has been tried. A large turntable has been inserted into the front board, upon this a sliding lid holding the lens. The idea of the inventor can easily be guessed by this dodge; he has a multiplying camera, that is to say, if his camera is for a whole plate, he can make four C. D. V. or quarter-plate views; if he leaves the lens in the center, he can take a whole-plate landscape. If he desires to employ four quarter-plates, the operator fixes two sheets of zinc in the front of the camera, next to the dark-slide, so that the first corner only remains open; he then pulls up the lens to position. When the exposure is finished, the sliding board holding the lens is pulled around, and the lens is then found at corner 2, the exposure is given, and the lens is then brought around to corner 3, and from thence to corner 4. Naturally the operator is supposed to have changed the strips of zinc in the front; if so, he has four pictures upon his plate. The operator can also have two half plates, either horizontal or upright, by bringing the

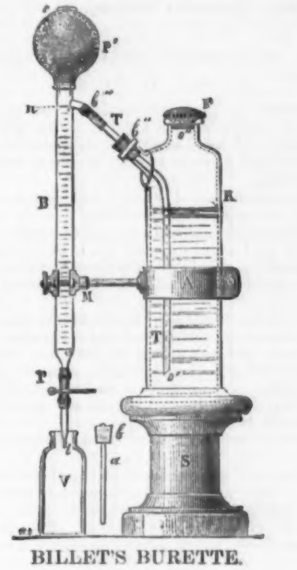


lens to the top, bottom, right, or left of the camera, and changing the zinc bands to coincide with what is required.—*Br. Jour.*

BILLET'S IMPROVED BURETTE.

MANY styles of burettes have been made, but the one that we figure herewith is of particular interest to chemists and analysts. It is of Mr. F. Billet's invention, and is manufactured by Mr. E. Ducretet. Referring to the figure, R is a reservoir containing the liquid to be titrated; S is a support for the reservoir; B is a burette divided into ⅕ cubic centimeters; A is a ring with clamp, M, for holding the burette; P is a Mohr pinchcock, which may be replaced by a glass cock terminating the burette; P' is a rubber bulb, with aperture, *o*; T is a glass tube connecting the reservoir and burette; F is the stopper of the reservoir, with aperture, *o'*; and V is a glass vessel, with stirring rod, *ab*, for receiving the liquid which flows from the burette.

The apparatus is used as follows: The liquid to be titrated is put into the reservoir, R, and the bulb, P,' is squeezed and then allowed to expand while a finger is held over the aperture, *o*. The liquid is thus sucked through the tube, T, into the burette, and the excess above the level, *n*—the zero of the burette's graduation—immediately flows out through T. The burette is thus filled and brought to zero quickly and automatically. It is always ready to operate without any de-



BILLET'S BURETTE.

canting of the titrated liquid. On opening the cock at P, the liquid from B flows into V, which is afterward closed with the stopper and rod, *ab*.—*La Nature.*

MINUTE-GLASS WITH ALARM.

A MINUTE-GLASS is often used for measuring a certain length of time, especially in boiling eggs, etc.; but in employing this apparatus it is necessary to keep constant watch of the sand, in order to know the instant when its flow ceases. The accompanying engraving illustrates an ingenious device, which we have noticed in the bazaars, and which does away with the inconvenience of watching the sand. When the latter has entirely run out, a counterpoise causes the glass to tilt, while a hammer fixed at the extremity of a metallic rod tilts at the same time and strikes a small bell at

MINUTE GLASS WITH ALARM.

the upper part of the support. The sound produced warns the operator, who in the interim has been enabled to busy himself with something else.—*La Nature.*

SEPARATING ZINC.

By Prof. W. HAMPE.

As a convenient means for the separation of zinc from iron, nickel, cobalt, manganese, and aluminum, the author recommends the conversion of these metals into formiates, and the treatment of the solution with sulphureted hydrogen. As far as his experiments extend, the zinc is always completely precipitated. The precipitate is always free from manganese and aluminum, and also from nickel, cobalt, and iron, if the solution contains a sufficiency of free formic acid (at least 15 to 20 c. c. of acid of spec. grav. 1·2 in 250 to 500 c. c. of liquid), and those metals are not present in too great excess. In other cases traces of foreign sulphides are sometimes mixed with the zinc hydrosulphide, and give it a reddish-brown tint. Iron is most easily thus carried down, nickel and cobalt less readily. These impurities are in quantity very trifling. For their entire removal the precipitate, after filtering and washing, is redissolved in nitric acid, supersaturated with ammonia, then with formic acid, and once more precipitated with sulphureted hydrogen. Such a repetition—certainly not always needed—of the separation would deprive this method of its essential advantages if we had not a means for making zinc sulphide capable of easy and rapid filtration. To this end sulphureted hydrogen is passed into the hot solution. The zinc sulphide falls as a granular precipitate which filters and washes quickly and clearly. For washing sulphureted hydrogen water is used to which a little ammonium formiate and formic acid have been added.

On passing sulphureted hydrogen into the hot solution, a little zinc sulphide (about 1 milligramme) is deposited on the sides of the glass so firmly that it can-

not be rubbed off. This film, after rinsing the glass, is dissolved off in a little nitric acid, and the solution is added to that of the main precipitate if the precipitation has to be repeated. If this is not necessary, or if the second precipitation is already in process, the nitric solution of the film is mixed with ammonia and ammonium sulphide, then with formic acid until the reaction is acid, and the whole is poured upon the filter to the precipitate, which is already washed.

When dry, the zinc sulphide is not horny and brittle like that thrown down from an acetic solution, but pulverulent, and it can be readily removed from the filter without loss.—*Chemiker Zeitung.*

GLYCERINE AND ITS USES.

By F. H. ALCOCK.

GLYCERINE is perhaps well known to be a useful addition to the sulphur type of lotion for the hair, as the sulphide of lead which is supposed to be formed renders the hair almost as stiff as a board without some such addition.

A very recent hair dye, and one which is said to be good, may be made by dissolving freshly prepared ammonio-tartrate of bismuth, or the ordinary scale citrate of bismuth and ammonia, in weak glycerine, and mixing this with a solution of hyposulphite of sodium in glycerine and water, and finely diluting with more water.

Teeth lotions have also come much into use, and of the many formulæ published the following is a type: Tincture of quillaia, eau de Cologne, water, borax, glycerine, with coloring. Such a combination is as excellent for its purpose as it is elegant in appearance.

Almost all cosmetic solutions are greatly improved by the addition of a little glycerine, Of these we may name freckle lotions, zinc oxide, and rose water lotions, calamine lotions, etc.

Liquid starch glosses and finishes have glycerine in them as a *sine qua non.* Here is an example from the *Popular Science News:* Spermaceti, 1 oz.; gum arabic, 1; borax, 1; glycerine, 2½; water, 14½; perfume, q. s. Three spoonfuls to be added to about 4 oz. of boiling water.

Lime juice and glycerine inseparable may easily be made by the subjoined formula, but I cannot say how how much will be the percentage of glycerine. A saturated solution of borax should first be prepared. Here is a note I made a long time ago: "One drachm of powdered borax to be dissolved in 21½ drachms distilled water, and during solution warmed slightly to keep the temperature just a few degrees above that of a summer's day, and to insure accuracy it is perhaps better to weigh the materials into a large size 3-oz. bottle. The oily material consisted of 14 parts of oil of almond and two parts of castor oil, thoroughly mixed. To this quantity of mixed oil was added, all at once, four parts of the solution of borax as named (each being accurately measured). On being well shaken, a very white uniform emulsion which did not separate resulted. I believe soap is sometimes added to this preparation to increase its white appearance and to prevent separation, but I do not know that it is a desirable addition, or that it is effectual in preventing separation." I have, up to this period, had no fault to find with my note.

Glycerine Jelly.—This combination may be made opaque or transparent. For the former, soap, glycerine, almond oil, and perfume are used; for the latter, isinglass, gelatine, or transparent soap, 1 oz., dissolved in glycerine and a little added water, this usually being a perfumed water.

I hope, by the introduction of a few brief notes under this head, that we shall not be doing any serious injustice to the medical profession.

Glycerine is reputed to be a safe and very effectual emetic for infants. As a substitute for cod liver oil, iodized glycerine with iodide of potassium forms a good tonic, etc., for phthisical patients whose stomachs are unable to bear this oil.

A combination of a fluid extract of *Cascara sagrada*, glycerine, and a little tincture of nux vomica is highly praised as a tonic laxative. Ferric chloride and its preparations are very astringent, and hence, when taken internally for some time as a tonic, are liable to do harm. This astringent effect is greatly counterbalanced by the addition by glycerine, with which this chalybeate is perfectly compatible.

An excellent simple remedy, in place of the old-fashioned rum and figs, for tightness of the chest and the cough of old people, is a mixture of 40 fluid drachms of glycerine, 10 of rum, with 1 minim of oil of anise or peppermint.

The combination, as an aperient, in doses of 1 drachm, of glycerine and castor oil in equal parts, is now so old that it has almost sunk into oblivion, but it is undoubtedly, when prepared *secundum artem* and with a little flavoring agent, a valuable and highly efficacious elegant preparation. The activity of the oil is said to be increased.

An excellent application for scalds and burns is composed of equal parts of glycerine and oil of peppermint. Glycerine, as an external application, is said not to be absorbed by the skin, hence it is of especial value as a basis when such agents as mercuric chloride, iodoform, etc., have to be superficially applied in cases of certain skin diseases, as scabies, etc. One and a half drachms, dissolved in 3 fl. oz. of glycerine, is reported to possess valuable powers in the treatment of scabies, etc.

Iodized glycerine prevents the pitting which may result after an attack of small pox. As a liniment, in combination with chloral hydrate, camphor, etc., it receives the commendation of sufferers from rheumatism.

When vaporized in a suitable apparatus, and its fumes inhaled, glycerine is a simple expedient in cases of bronchial affections and distressing coughs; and here we may remark that many eminent vocalists are fully alive to the value of this substance as a voice strengthener and throat invigorator.

Salicylate of sodium, dissolved in glycerine, has its medicinal effects greatly enhanced. A good remedy for dyspepsia consists of pepsine, sherry, glycerine, and tartaric acid.

Naphthaline, recommended as an antiseptic agent with a view to checking diarrhœa, and said to be efficacious in cases of intestinal catarrh even when chronic, may be administered in glycerine, in which it is soluble when the solvent is slightly warmed. Indirectly connected with glycerine is the use of nitro-glycerine, as a 1 per-cent solution in diluted alcohol, for neuralgia, etc.

Mercuric iodide, with glycerine, is a good paint for corns.

An excellent simple febrifuge drink is thus made: Glycerine, ℥ j; citric acid, ʒ ss; water, ℥ vj. Dose, 1 to 2 tablespoonfuls every hour for an adult.

Glycerine is very largely used in the manufacture of printing, stamping, and letterpress inks, as also in the preparation of inks for the numerous forms of "graphs." The following is an example of an indelible stamp ink taken from the *Pharmaceutical Record:* Sodium bicarbonate, 22; glycerine, 85; gum arabic, 20; nitrate silver, 11; solution of ammonia, 20; Venice turpentine, 10; mix according to art. For ribbon ink: Concentrated glycerine and alcohol, of each 15; aniline, ½ oz. Blacking of excellent quality can be made by means of a judicious combination of soot, glycerine, oils, etc.

A good "graph" is readily made from Russian glue, 2; water, 1½; glycerine (1·260), 5 parts by weight. As these sometimes get mouldy, we may mention a wrinkle which will prevent the proneness of gelatine to this trouble. It is simply to dissolve a few grains of boracic acid in the glycerine before incorporating with the other materials.

In the process of vulcanizing India rubber glycerine is found to be of service. It appears that the India rubber acquires properties which protect it from oils and fats without interfering with its other properties.

For silvering and gilding glass we find our subject again in request by reason of its reducing action on the salts of silver and gold, and also because the deposit thus produced is of a brilliant metallic luster. An ammoniacal solution of nitrate of silver is first prepared, and in it is poured a little solution of caustic potash, and then a few drops of glycerine. It is then ready for immediate use, since reduction begins at once, which process is accelerated if a little ether or alcohol be also added to the mixture. The result is said to be most brilliant when a moderate heat is used, and darkness is said to favor the adhesion of the deposit to the mirror.

A polish for leather is thus made: Shellac, 200; spirit, 1,000; Marseilles soap, 25; spirit, 25 per cent., to dissolve soap, 375; glycerine 40; to which is finally added 5 nigrosin in 125 spirit.

Mineral water manufacturers are now availing themselves of the advantages to be derived from the use of glycerine in the preparation of the liquors and flavors, etc., which are much in request as beverages.

Glovers use large quantities of yolks of eggs in certain processes involved in the manufacture of kid gloves. An addition of a few percentums of glycerine is said to be a decided advantage. Glycerine preserves the yolks for a long time.

In the preservation of anatomical and other specimens its value is well established, but a little point will perhaps be useful to bear in mind. About six years ago a friend presented me with a nice specimen of the ripe fruit and fresh leaf, with tendrils, of the *Bryonia dioica*, which I placed in a bottle with some glycerine and water, but now, although in good condition as far as preservation goes, I find the berries have become wrinkled and some have collapsed, which, I believe, is probably due to a process of osmosis, the liquid within the fruit being of a different gravity from the preservative fluid. If I had first ascertained the gravity of the juice, and made my glycerine solution of a similar gravity, if such had been possible, I think the shape of the fruit would have been retained.

For the preservation of cider, glycerine of salicylic acid is admirable, a very small quantity keeping it good for over twelve months.

A solution of alum, arsenic, and niter in glycerine is said to be an admirable preparation for "curing" animals' skins. I have a cat's skin which has been successfully prepared with this combination.

To render corks impervious, soak them several hours in a solution composed of ½ oz. glue or gelatine, ¾ oz. glycerine, and a pint of water heated to 50° C. After such a treatment they are nearly proof against many corrosive liquids, but are more completely so if they are first well dried and then dipped in a mixture of four parts of paraffine and one of petrolatum, or simply ordinary petroleum oil.

The easiest and safest method of preparing this explosive is that which was first introduced by Messrs. Boutmy and Foucher, and which as a new and safe method obtained the prize of 2,500 f. offered by the French Academy of Sciences. First by converting the glycerine into sulpho-glyceric acid, and in this form bringing it into contact wilh the nitric acid, to which an equal weight of sulphuric acid has been previously added.

The details of the process are as follows:

One part by weight of pure glycerine (1·260) is thoroughly mixed with 3 parts of strong sulphuric acid (1·842); there is at once a considerable evolution of heat, and the glycerine is slightly discolored. In a separate vessel a mixture of 3 parts (also by weight) of sulphuric acid and 3 parts of nitric acid (1.4) is made, and both mixtures are then allowed to cool down to about 15° C. The next step is to transfer the two cooled liquids to a tall cylinder, and well stir them together, when a slight rise in temperature (to about 20° or 25° takes place, followed, after the lapse of half an hour or so, by a cloudiness of the acids, due to the separation of minute drops of nitro-glycerine. After standing for about twenty hours the formation of the oil is complete, the whole of it having risen to the surface of the acid mixture; it may then be siphoned off, dissolved in an equal volume of ether, to facilitate its separation, shaken up with successive portions of water until the washings fail to redden blue litmus, and, finally heated on a water-bath until its weight remains constent. The nitro-glycerine will now be light brown in color, and should have a specific gravity of 1·6, and should detonate readily and powerfully when fired by percussion, or by means of a fulminating charge. This substance may be easily recognized by the violent but transitory headache which is experienced on placing an exceedingly small quantity (1-1,000th of a grain or thereabout) on the tongue.

In the old processes the nitro-glycerine separates almost instantaneously and rises in part to the surface, thus rendering washing difficult. In the process above described its formation is gradual, and extends over a long period of time.

The barometic records made for the *Times* newspaper are from a glycerine barometer. In place of the column of mercury of about 30 inches length, a tube about 27 feet long is used, containing ¾ of a gallon of glycerine colored red with aniline. The great advantage of this fluid is that readings can be taken more accurately, for, when subjected to the weight of the atmosphere, while mercury would move 1-10 inch, the height of the glycerine column would be moved through a space of 1 inch. One objection has to be provided against, *i. e.*, the hygroscopic nature of glycerine, its power of absorbing water from the air being very great. This is remedied, however, by putting a layer of heavy petroleum oil in the cistern of the barometer. There is a glycerine barometer at the Kew Observatory, which also required for its construction ¾ of a gallon of glycerine, and, in order to obtain the correct height, the tube passes through two rooms, the cistern being in one and the column read off in the one above.

This fluid, on account of its high boiling point and low freezing point, is of constant use in scientific experiments.

Carbolic acid is said to be an adulterant of ordinary or wood-tar creosote. The former is well known to be soluble in glycerine (glycerinum acidi carbolici), and on the addition of water forms a clear solution. Creosote forms a nearly clear solution with this liquid when of sp. gr. 1·260, but on dilution with water it separates out again.

When gallic acid is warmed for a long time with glycerine, even at a low temperature, pyrogallol results, and this process is taken advantage of by photographers, who use a combination of glycerine and pyrogallol or pyrogallic acid in some of their operations.

A delicate test for glycerine is to take 2 drops of carbolic acid with 3,000 to 5,000 drops of water, and add 1 drop of solution of ferric chloride; in the absence of glycerine a blue color results, but if it be present the color does not form. If coloring matters or sugar is present in the suspected liquid, they must first be removed. To do this calcic hydrate is added to the liquid to be tested, with some powdered marble, and evaporated, and the mass then exhausted with a mixture of alcohol and ether; the alcoholic solution evaporated to remove ether and alcohol, and the residue mixed with water, and the test applied, first neutralizing any alkali, should any be present. This may be available as a qualitative test for the presence of glycerine in beers, wines, beverages, etc.

The value of glycerine jelly for mounting microscopic objects needs only a passing comment; its manipulation is very easy, and well suited to the tyro embarking in the study of histology of animals and plants.

The fact that glycerine when present in a solution often greatly interferes with the usual chemical reactions should always be borne in mind. Thus ferric bromide mixed with glycerine, and then sulphocyanide of potassium added, gives the usual red color, but ether does not remove that color and impart it to itself. Again, if ferric bromide be added to sulphocyanide of potassium, and then ether added, we get all that we expect, but on the addition of glycerine the ether becomes colorless again. Glycerine also removes auric chloride and uranium nitrate from their ethereal solutions; so, too, an ethereal solution of mercuric chloride, when agitated with glycerine, is found to hand over the greater part of its solvent to the latter solvent.

Glycerine has very recently been used in a process for the preparation of chemically pure metallic bismuth. Ordinary commercial bismuth is dissolved in dilute nitric acid, and the solution mixed with water until turbidity begins to appear; then a sufficient quantity of fixed alkali is added in solution to precipitate the bismuth and render the solution alkaline; twice the volume of the alkaline solution is now added, and glycerine in sufficient quantity stirred in to redissolve the precipitate; filter if necessary. The filtrate is now mixed with a solution of pure glucose (1 : 6 or 8), and laid aside for some time in the dark; filter again. The filtrate is now boiled and well stirred, when finely divided bismuth is deposited, which must be filtered away, washed, and dried as rapidly as possible.—*Chemist and Druggist.*

A NEW PROCESS FOR EFFECTING THE LIQUEFACTION OF OXYGEN.

By L. CAILLETET.

LIQUID ethylene when boiling in the free air gives a degree of cold such that oxygen, if compressed and cooled to this temperature, presents, on diminishing the pressure, a tumultuous ebullition which lasts for an appreciable time.

On quickening the evaporation of the ethlyene by means of the pneumatic machine, as Faraday did for nitrogen monoxide and carbon dioxide, the temperature is lowered so far as to bring the oxygen to a liquid state. The author has endeavored to avoid the inconvenience and the complication resulting from the necessity of operating in a vacuum. For this purpose he has already proposed the use of liquid formene, which enables us to obtain at once the liquefaction of oxygen and nitrogen. In spite of these advantages, ethylene, which is so easy to prepare and to manage, is preferable to formene, and he has sought to obtain by means of ethylene boiling in open vessels a reduction of temperature sufficient for the complete liquefaction of oxygen. The process employed is exceedingly simple; it consists in intensifying the evaporation of the ethylene by forcing into it a current of air or of hydrogen cooled to an exceedingly low temperature.

In the apparatus employed, the steel receiver which contains the ethylene is fixed to a vertical stand, with its aperture turned downward. To this aperture is adapted a copper worm of three to four millimeters in diameter, and closed at its lower end by a screw-cock. On cooling the worm to —70 degrees by means of methyl chloride the ethylene which accumulates there has at this temperature a very feeble pressure only, and flows out without sensible loss on opening the exit-cock. This new arrangement, which has been adopted both for ethylene and formene, enables these condensed gases to be cooled, as if the entire reservoir containing them was refrigerated to the temperature of the worm.

The ethylene is received in cylinders of thin glass placed in a glass vessel containing dry air; it is then merely necessary to intensify the evaporation of the ethylene by means of a rapid current of refrigerated air or hydrogen to permit the oxygen condensed in a

glass tube to become a colorless liquid, transparent and separated from the stratum of gas above it by a perfectly distinct meniscus.

The author has measured with a hydrogen thermometer, the construction of which will shortly be described, the temperature of the ethylene, which in one of the experiments was found to be—123 degrees. He hopes that by cooling the hydrogen more carefully a lower point may be reached.

The copper worm in which the air and the ethylene circulate are immersed in methyl chloride, which is evaporated rapidly by means of a current of air previously refrigerated.

Finally he has ascertained that on promoting the evaporation of the liquid ethylene by means of a current of air or of hydrogen strongly refrigerated, its temperature may be reduced quite below the critical point of oxygen, which, in this medium, is most distinctly liquefied.—*Comptes Rendus—Chem. News.*

ACETYLENE.

ACETYLENE is a colorless gas of disagreeable odor, which has been well known only since the time of Berthelot's researches upon it. It was this chemist, in fact, who showed that carbon and hydrogen unite directly at the high temperature of the electric arc to form acetylene. This important fact can be very clearly shown by means of an ovoid vessel of thick glass, having a capacity of about three and a half pints, and provided at the apex with two tubulures. Into this there is introduced a current of hydrogen furnished by a powerful generator, and the flow of which is kept up until all the air has been expelled. When the gas collected at the orifice is pure hydrogen, the gaseous current is moderated. Any air remaining in the vessel would cause an explosion during the experiment. Then about an ounce and a half of ammoniacal subchloride of copper is poured into a large flask placed in the line of the gaseous current; and two rods of carbon placed in the ovoid vessel are brought into contact, thus closing the circuit of the electric generator.

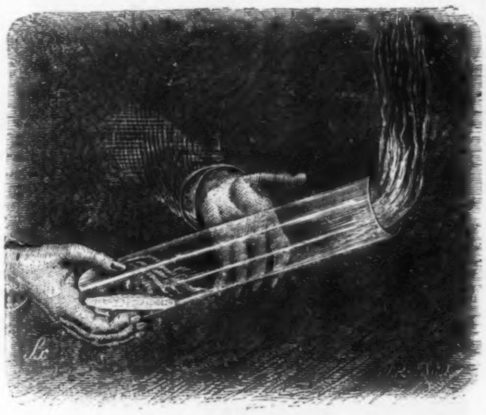


FIG. 1.—FORMATION OF ACETYLENE BY INCOMPLETE COMBUSTION.

The electric arc that is at once formed is maintained by keeping the carbons a proper distance apart. Under these circumstances, the hydrogen, in order to make its exit from the vessel, must traverse the electric arc. In doing so it unites directly with the carbon and forms acetylene, which is carried along to the flask and brought into contact with the reagent. This latter gives rise to a cupreous acetylide of a beautiful red color. If care has been taken to shake the flask so as to spread the reagent over the sides thereof, the latter will become opaque and of a bright red almost immediately. The experiment is a very brilliant one.

Acetylene is a constant product of incomplete combustion, that is, such as takes place in the presence of an insufficient quantity of oxygen.

When, after introducing from 18 to 30 cubic inches of common ether into a test glass, along with an equal bulk of the cupro-ammoniacal reagent, a burning object be brought near the mouth of the inclined vessel (Fig. 1), the vapors from the ether will ignite and give an illuminating flame. As the interior portions of the latter (those near the orifice) are insufficiently supplied with oxygen, the gases that they produce, and which partially re-enter the test glass, are abundantly charged with acetylene. This latter at once precipitates the cupro-ammoniacal reagent. The cuprous acetylide will form in large quantity if the glass be held horizontally and revolved around its axis, since the reagent then spreads more widely over the sides. Care should be taken not to allow any of the combustible liquid to escape from the glass. The same experiment may be performed by substituting benzine, kerosene, and very volatile hydrocarbons in general for the ether. It likewise succeeds with hydrocarbureted gaseous combustibles.

When it is desired to prepare and collect acetylene, the cupreous acetylide is decomposed by hydrochloric acid. The operation is performed in a round glass vessel provided with an eduction tube. Into this there is introduced a thick paste of washed cuprous acetylene, along with some hydrochloric acid. The reaction begins at the ordinary temperature, although the mixture must be heated a little. The gas is collected over mercury.

The cupreous acetyle requisite for preparing pure acetylene is most easily procured by incomplete combustion. The extreme oxidizability of the ammoniacal subchloride of copper, and also the very rapid destructive action exerted by this oxidized reagent upon the cupreous acetylide that it holds in suspension, require that the conditions under which the operation is performed shall prevent free oxygen from mixing with the products of incomplete combustion. This is easily effected by the apparatus represented herewith (Jungfleisch's), which permits of preparing the acetylide by the incomplete combustion of illuminating gas.

When a jet of air is burned in the midst of an atmosphere of illuminating gas that surrounds it on all sides, the combustion, which proceeds regularly at the surface of separation of the two gases, is incomplete, and its products, mixed with illuminating gas in excess, cannot get mixed with oxygen derived from the air. Such is the principle applied.

The apparatus (Fig. 2) consists of two parts, viz., of a burner, LV, in which incomplete combustion is effected, and of a number of parts, CRR'FF', designed for removing the acetylene from the products of such combustion. The essential part of the burner is shown in section in Fig. 3. We begin by lighting the burner. Lowering this latter as much as possible by means of the movable standard, *p*, we remove the glass, turn the collar, *oi*, in such a way as to allow but little air to enter, let a small quantity of gas enter the burner, and at once light it, and replace the glass in the oiled channel. Then, raising the apparatus, we place it in its normal situation. A very small flame is produced at N, at the orifice of the central tube, and the surplus gas escapes at O, along with the products of combustion. We now light A', and simultaneously increase the gas and air in the burner, L. A voluminous flame will at once make its appearance at O. We now operate the tromp so as to produce a very rapid bubbling at F'. The flame will at once diminish at O, and it now only remains to regulate the burner. The essential point is to keep up at the surface of the air entering at V a regular flame surrounded on all sides by gas, and to allow no trace of oxygen to escape; in other words, to produce a *closed flame* at V. If the tromp acts well, the internal flame, when too much gas is given, will diminish in height, and the combustion at O will produce an illumination; on the contrary, when too much air is given, the internal flame will lengthen, open toward the top, and become reddish, while the noncombustible gases will escape at O. The combustion that furnishes the gas richest in acetylene is obtained by a few experiments founded upon the previous observations, and corresponds to the production at O of a pale flame, which is tinged with purple and is easily extinguished, and the height of which is regulated to a few fractions of an inch—the tromp being regulated once for all. The internal flame is then enveloped in yellow, and is elongated and slightly fuliginous. The gas that it furnishes contains about three one-hundredths of acetylene. The production increases up to a certain limit with the rapidity of the suction.

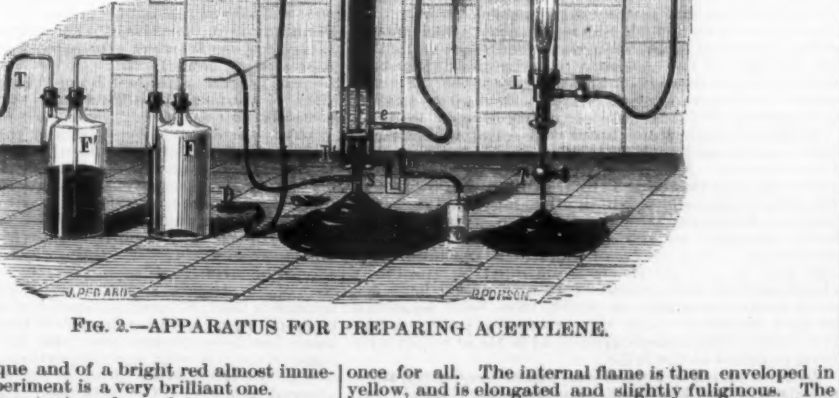


FIG. 2.—APPARATUS FOR PREPARING ACETYLENE.

It is necessary to keep up a constant combustion at O. The characters presented by the flame serve for regulating the apparatus. The gases, that are more or less charged with oxide of carbon and cynohydrate of ammonia, must not be allowed to escape incompletely burned into the atmosphere. Finally, and especially, the exit of the combustible gas at O, showing that an excess of pressure exists at V, and that air cannot be sucked in between the glass and the tube, must be kept up.

Even with a rapid operation, three wash bottles, like those shown at F', usually suffice to almost entirely absorb the acetylene formed. When the liquid in the first bottle gets thick and no longer acts, the bottle is removed and replaced by one of the others. At the time of changing the wash bottle, communication with the tromp must first be cut off, so as to prevent air from entering the reagent. The combustion thus forms a long flame, which escapes at O. If care has been taken not to change the regulation of the burner, it will, as soon as the last bottle is put in communication with the tromp, operate just as it did before.

This apparatus, when actuated by a tromp of large discharge that any one can easily arrange for himself, permits of obtaining large quantities of cupreous acetylide in a short time. The product must be protected from the air, and be washed, as before stated.—*Science et Nature.*

OXYGENATED WATER.*

SINCE Schoenbein's researches, the process of "grass-bleaching" was attributed to the influence of ozone, but the new and very exact experiments of Emil Schoene, together with the earlier labors of Houzeau and Goppelsroeder, have proved that the reactions formerly attributed to ozone really owe their origin to oxygenated water. Repeated quantitative analyses showed that the richness of the air in peroxide of hydrogen varies according to the seasons of the year, the hours of the day, the direction of the wind, etc.; but Schoene attributes a predominant influence to the light. Rain, but especially dew in certain cases, contains a considerable proportion of oxygenated water, namely 0·04 mgm. to 1 lit. liquid; the quantity which the soil receives in this way amounts to 62·9 mgm. per square meter.

Although "grass-bleaching" has been known and practiced for centuries, and there was plenty of time and labor employed to its improvement, it cannot be denied that this procedure has its many great drawbacks. The success of a bleach upon the meadow can never be foretold to a certainty in a given time; the bleaching always requires a long time, and "time is money." These considerations show what profit would be derived from replacing the natural bleaching by the preparation of a more concentrated form of oxygenated water.

Chemistry offers a numerous series of combinations in which the oxygen is but feebly held, and which easily surrender it to other substances. These oxidizing agents can be used instead of the air in bleaching, and those which are practically employed for that purpose are nitric and nitrous acids, permanganic acid, chloric acid, chlorous acid, and finally chlorine, either in a gaseous form or in combination with bases. But all these products, however different from each other, have the inconvenience of more or less attacking the fibres; oxygenated water alone has not this fault; it contains in a more concentrated form the active principle of the best kind of bleaching, that is, of grass-bleaching; it is superior, therefore, to all those products, and may be considered as the bleaching agent that is to rule in the future.

Thenard, in 1818, discovered the peroxide of hydrogen; it was obtained by the action of acids upon barium peroxide in the presence of water. Since then, oxygenated water has been the subject of investigations by Pelouze, Duprez, Balard, J. Thomson, E. Schoene, etc., but without achieving an improvement in the manner of its production; only very dilute solutions were obtained with possible 5 per cent. peroxide contained in them. The pure product H_2O_2 is hardly obtainable on account of its utter decomposibility. There are but two ways of concentrating the solutions; either by freezing, or by evaporating in a vacuum at 59°–68° F., over sulphuric acid.

Pure peroxide of hydrogen is a sirupous liquid, of 1·453 density, whose decomposition yields 475 times its own volume of oxygen. Its dilute solutions are analogous in their action to chlorewater, and can be preserved for months, if kept in the dark at a temperature not above 77° F. They keep better yet if a trace of acid is added to them; while alkalies or liquids of alkaline reaction promote decomposition. This inclination of oxygenated water to set oxygen free places it among the oxidizers. There are many substances which provoke this decomposition without undergoing themselves any modification, such as alum jelly, oxyhydrate of iron, charcoal, some metals in a condition of extremely fine division, silver, gold, and platina. With another class of bodies, the oxygenated water behaves like many other oxidizing agents, that is to say, it surrenders its oxygen; for instance, with arsenious acid it produces arsenic acid, and transforms the metallic sulphides into sulphates. Upon certain peroxidized substances, finally, the oxygenated water can act reducing, for instance upon the peroxides of lead and of manganese, which are reduced by its presence to the oxide state.

All chemists who have occupied themselves with this subject are unanimous in predicting a brilliant future for the employment of oxygenated water. Dumas, in 1830, recommended it for cleaning old paintings, because the lights of paintings become black by the transformation of the white lead into sulphide of lead, which being retransformed into sulphate by the action of oxygenated water, the light colors must be restored to their original appearance. Oxygenated water, however, was ignored for a long time, until in 1870 a perfumer availed himself of its bleaching properties, to introduce a 3 per cent. solution of it as a hair dye under the names of "Auricome" or "Eau de Fontaine de Jouvance dorée." About the same time A. Von Schroetter, R. Boettger, Geiger, and Hagen directed the public attention to the therapeutic properties of oxygenated water.

The difficulties of preparing pure oxygenated water on a grand scale, causing its formerly high price, have been at present overcome, so that a 3 per cent. (by weight) aqueous solution can be had at a moderate price and in any quantity. With its excellent bleaching properties and safety of application the road seems to be opened, therefore, for its extensive utilization in industries.

* From a lecture held by Dr. P. Ebell, at Hanover.

THE TOPOPHONE.

THE aim of the topophone is to enable the user to determine quickly and surely the exact direction and position of any source of sound. Our figure shows a portable style of the instrument; for use on shipboard it would probably form one of the fixtures of the pilot-house or the "bridge," or both. In most cases arising in sailing through fogs, is would be enough for the captain or pilot to be sure of the exact direction of a fog horn, whistling buoy, or steam whistle; and for this a single aural observation suffices.

Every one has twirled a tuning fork before the ear, and listened to the alternate swelling and sinking of the sound, as the sound waves from one tine re-enforce or counteract those from the other tine. The topophone is based upon the same fact, namely, the power of any sound to augment or destroy another of the same pitch, when ranged so that the sound waves of each act in unison with or in opposition to those of the other.

Briefly described, the topophone consists of two resonators (or any other sound receivers) attached to a connecting bar or shoulder rest. The sound receivers are joined by flexible tubes, which unite for part of their length, and from which ear tubes proceed. One tube, it will be observed, carries a telescopic device by which its length can be varied. When the two resonators face the direction whence a sound comes, so as to receive simultaneously the same sonorous impulse, and are joined by tubes of equal length, the sound waves received from them will necessarily re-enforce each other, and the sound will be augmented. If, on the contrary, the resonators being in the same position as regards the source of sound, the resonator tubes differ in length by half the wave length of the sound, the impulse from the one neutralizes that from the other, and the sound is obliterated.

Accordingly, in determining the direction of the source of any sound with this instrument, the observer, guided by the varying intensity of the sound transmitted by the resonators, turns until their openings touch the same sound waves simultaneously, which position he recognizes either by the great augmentation of the sound (when the tube lengths are equal), or by the cessation of sound, when the tubes vary so that the interference of the sound waves is perfect. In either case the determination of the direction of the source of the sound is almost instantaneous, and the two methods may be successively employed as checks upon each other's report.

It is obvious that with such a help the pilot in a fog need never be long in doubt as to the direction of a warning signal; and if need be he can without much delay, by successive observations and a little calculation, determine, approximately at least, the distance of the sounding body.

PROFESSOR MAYER'S TOPOPHONE.

FONVIELLE & LONTIN'S ELECTRICAL MOTOR.

THIS little apparatus, which was presented to the Academie des Sciences at its session of April 5, is composed of a galvanometric helix (Fig. 1) in which there is a small soft iron disk capable of revolving on its supporting pivot. If, on arranging a horseshoe magnet over this apparatus in such a way that its polar extremities are at the ends of the frame, an induction current from a small induction coil be sent into the wire of the helix, the disk begins to revolve rapidly and in a perfectly definite direction, which is dependent on the position of the poles of the magnet and on the direction of the currents induced in the wire of the galvanometric helix. When the magnet is crosswise, there is no longer any rotation. The phenomenon has been explained very simply by MM. Jamin and Du Moncel. As well known, the current induced by breaking is always more powerful than that induced by closing. The disk of soft iron polarized by the outer magnet behaves like a magnetized needle placed in a galvanometric helix, and assumes its motion under the action of a series of electrical impulses, the poles remaining fixed in space, while the disk displaces itself by its rotation. The current produced by closing the primary circuit of the induction coil acts in a direction opposite to that produced by opening, but as its intensity is much less, the disk moves under the differential action of the two. Each current induced by closing produces a new impulse on the disk, since the poles are always in the prolongation of the fixed magnet.

The same rotary motion is produced with the *direct current of the battery interrupted with sufficient rapidity*. In this case the rotary speed is not so great, but this must be attributed to the fact that the electrical impulses are not produced with sufficient rapidity, and that, moreover, the resistance of the galvanometric helix is not so well adapted to the direct current. The motion is quite rapid when the current of the battery is sent and made to traverse the inductor of the coil and the vibrator, for there is then produced a series of impulses which are sufficiently rapid to communicate a certain rotary speed to the disk. On arranging two helixes (Fig. 2) in the circuit of the secondary wire of the coil, a movable disk may be made to revolve in each helix; but on removing the disk from one of the helixes the disk in the other takes an accelerated velocity. To explain this phenomenon, which appears to have somewhat astonished M. De Fonvielle, we have only to bear in mind the well-known reactions of magnets and currents. The rotatory motion is produced also with movable pieces of soft iron of various shapes—needles, stars, whole disks, split or annular, spiral bands, etc. On doing away with the fixed magnet the phenomenon takes place under the action of terrestrial magnetism, although to a less degree. The fact that there is no motion when the magnet is placed crosswise with the spirals of the galvanometer proves the exactness of M. Jamin's theory; for in this case the disk in the interior of the galvanometric helix forms, under the influence of the external horseshoe magnet, a true magnetized bar placed crosswise with the current, and consequently cannot assume any motion under its action. MM. Lontin and De Fonvielle's apparatus constitutes a new and orginal form for demonstrating the laws which govern the action of magnets and currents, and, as such, will take its place in physical cabinets alongside of analogous apparatus of Ritchie, Barlow, Faraday, etc.

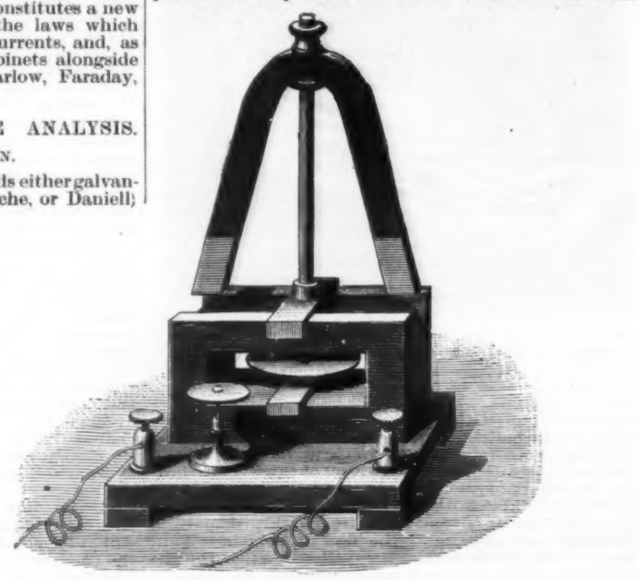


Fig. 1.—FONVIELLE & LONTIN'S ELECTRICAL ROTATOR.

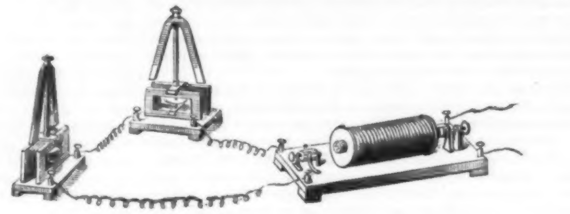


Fig. 2.—Arrangement of two rotators mounted in tension in the induced circuit of a Ruhmkorff coil.

ELECTROLYTIC QUANTITATIVE ANALYSIS.

By ALEXANDER CLASSEN.

FOR electrolysis the author recommends either galvanic elements (Bunsen, Meidinger, Leclanche, or Daniell) or thermo-electro batteries. Meidinger's elements, which furnish constant currents for a long time, are available only in special cases, *e. g.*, for the precipitation of copper, bismuth, and cadmium, since even when a great number of such elements are in connection the strength of the current is insufficient for quantitative separation of most metals from the solutions of the double oxalates. These elements may either be dispensed with or replaced by the Bunsen element. For the production of feeble currents, *e. g.*, for the determination of copper, two Bunsen elements are connected with their similar poles so as to form a single large element. This combination is applicable for the determination of the above-named metals, which, if too rapidly reduced, are separated in a spongy condition.

Thermo-electric batteries are not recommended, as the strength of their current is insufficient for many determinations and as they easily get out of order. The author now uses a small Siemens magneto-electric machine, provided with an arrangement for modifying the strength of the current at will, by modifying both the velocity of revolution and the resistance. By this means he obtains currents of from 7·46 to 0·02 ampere (1 ampere = 10·436 c. c. of detonating gas per minute).

He uses a single stand fitted with a ring for the platinum capsule and with an insulated arm for the positive electrode. As a negative electrode he uses a thin platinum capsule about 35 to 37 grm. in weight, 9 centimeters in diameter, 4·2 in depth, and 225 c. c. in capacity. Nickel capsules lined with platinum, as formerly proposed by the author, have not been found serviceable. As a matter of course, the platinum capsule used as a negative electrode must be absolutely clean and free from grease. Capsules which have become rough internally, or which have been scratched or bent, cannot be used. Several metals do not deposit as well in hammered capsules as in those which have been polished at the lathe.

Determination of Copper and Cadmium.—Both these metals can be deposited quantitatively, using two Bunsen elements so connected as to form a single large element. In place of dilute sulphuric acid a 15 per cent. solution of ammonium chloride may be used. From ten to twelve hours are required for the deposition of about 0·15 grm. of copper or cadmium. The end of the process, in case of copper, is preferably ascertained by means of a recently prepared solution of potassium ferrocyanide. The circumstance that copper can be quantitatively deposited from a solution mixed with ammonium oxalate in excess may be used for its separation from those metals which can be reduced only by more powerful currents.

Separation of Copper from Iron.—Mixed solutions of iron-alum and copper sulphate, containing an excess of ammonium oxalate, and electrolyzed. To determine the iron in the liquid after removal of the copper, a few more grammes ammonium oxalate are added, and the liquid is electrolyzed by means of two Bunsen elements connected in tension. The separation of nickel and cobalt from copper is effected in the same way as that of iron.

Separation of Copper from Chromium.—In presence of chromium oxide the copper separated is distinguished by its brilliance, a phenomenon which the author has constantly observed in the electrolysis of iron, nickel, and cobalt salts in presence of chromium oxide.

Separation of Copper from Manganese.—If the ammonium double oxalates of both metals are electrolyzed as above mentioned, only a small part of the manganese is separated out at the positive electrode. The electrolysis of the solution requires a very constant current, as, if the reduction is too slow, manganese peroxide may be partially deposited at the negative electrode.

Separation of Copper from Zinc.—The separation of copper from zinc in a solution of the double oxalates is practicable only when the current is not allowed to act longer than is required for the deposition of the copper. The separation is easy if we electrolyze a solution of the two metals acidified with sulphuric acid.

The separation of copper from arsenic and antimony does not succeed if the quantity of the two latter is at all considerable. On the electrolysis of the double ammonium oxalates of copper and mercury, and copper and bismuth, both metals, as might be expected, are deposited. Cadmium can also not be separated quantitatively from copper by the electrolysis of the above-named double salts, or of the sulphuric solution. But if the solution is acidified with nitric acid, both metals may be separated quantitatively.

Determination of Antimony.—Antimony can be separated electrolytically from a cold solution containing ammonium sulphide in excess. Neither free ammonia nor ammonium polysulphides must be present, otherwise the deposition is not quantitative. It is best to use ammonium hydrosulphate, which should be preserved for use in small stoppered bottles. A current representing from 1·5 to 2 c. c. per minute of detonating gas is most suitable. The reduction of large quantities of antimony is difficult, 0·15 to 0·2 grm. of the metal being the limit. The separation of antimony is always practicable with sodium or potassium monosulphide or hydrosulphide in place of ammonium sulphide. Here also the quantity of antimony must not exceed 0·2 grm., and polysulphides must not be present, neither must the sulphides used contain any impurity of iron or alumina, since otherwise iron sulphide and aluminum hydroxide are deposited upon the antimony. The antimony solution after admixture with alkali sulphide should be strongly diluted with cold water. If a current of the strength of 2 to 3 c. c. detonating gas per minute is used, 0·1 grm. antimony is deposited in four to five hours. In order to find whether all the antimony has been precipitated, the liquid is allowed to come in contact with a clean portion of the inner surface of the latter by inclining it, and the current is then allowed to act for fifteen minutes. If the platinum surface remains clean, the precipitation is complete. The liquid should not be allowed to become hot during electrolysis.

Determination of Tin.—Tin behaves like antimony. The solution is neutralized, if needful, with ammonia, mixed with a sufficiency of ammonium sulphide, large-

ly diluted with water, and electrolyzed with two Bunsen elements. Sodium and potassium sulphides cannot be used, at least not in a dilute solution.

Determination of Platinum.—The compounds of platinum are readily decomposed by the galvanic current, the metal being deposited at the negative electrode. A single Bunsen element is sufficient. Platinum can be determined in its salts by slightly acidulating the solution with hydrochloric or sulphuric acid, or mixing with ammonium or potassium oxalate and electrolyzing at a gentle heat.

The inaccuracy of the determination of potassium as platinum potassium chloride is well known. It might be preferable in accurate determination of potassium (ammonia and nitrogen determinations) to determine the platinum by the electrolysis of its double salts, especially as the separation of the platinum takes less time than the desiccation of the platinum compounds.

Separation of Iron from Cobalt.—The solution of the double oxalates is electrolyzed by means of two Bunsen elements connected in tension, the total weight of both metals is determined, and then the iron is estimated volumetrically. In carrying out the process, the solution is mixed with a few c. c. of potassium oxalate, (1 : 3) from 2 to 4 grms. of ammonium oxalate according to the quantity, and the liquid is then electrolyzed at a gentle heat. The electrolysis is complete in from three to five hours. On titrating the solution of the two metals nickel sulphate must be added to compensate the red color of the cobalt.

Separation of Iron and Nickel.—The process is exactly as in the last mentioned case. Iron and nickel separate out in the form of a white alloy, which dissolves slowly in hot hydrochloric acid. The solution is then oxidized with hydrogen peroxide, and after expelling excess the ferric chloride is titrated with stannous chloride.

Separation of Iron and Zinc.—If the double oxalates are electrolyzed there is deposited at the negative electrode, not an alloy, but zinc with a little iron. The process goes on smoothly, and the sum of the two metals can be readily determined if the zinc is less than one-third of the iron. If the proportion of the former metal is higher, the determination is impossible, as the zinc redissolves, with an abundant escape of gas, and ferric oxide is precipitated.

Separation of Iron from Uranium.—A large excess of ammonium oxalate is needed. The reduction of the iron is quickly effected by means of two Bunsen elements. Stronger currents are not to be recommenced. After the determination of the iron the solution of uranium is freed from oxalic acid by further electrolysis with stronger currents, and the ammonium carbonate is driven off by heat. The finely divided uranium precipitate is dissolved in hot nitric acid and thrown down with ammonia.

Separation of Zinc and Chromium.—The quantitative separation of zinc and chromic oxide is readily effected by means of a small excess of ammonium oxalate and a current of about 10 c. c. of detonating gas per minute. To determine the chrome, the oxalic acid is destroyed and the chromium oxide peroxidized by continued electrolysis, the liquid is boiled, reduced again with alcohol and hydrochloric acid, and the chromium oxide precipitated.

Separation of Zinc from Uranium.—The separation is effected by means of two Bunsen elements with a large excess of ammonium oxalate. After removal of the zinc the uranium is determined as above.

Separation of Chromium Oxide from Uranium.—The separation depends on the electrolysis of the double ammonium oxalates and oxidation of the chromium sesquioxide to chromic acid by the current. The uranium is precipitated as hydroxide, and the chromium remains in solution as ammonium chromate. The electrolysis must be continued until the oxalic acid is totally decomposed. The liquid is then boiled, allowed to stand for six hours, and the chrome determined as above.

Separation of Cobalt from Chrome.—This process resembles the separation of zinc and chrome. The cobalt is separated from the solution of the ammonium double oxalates, and the chrome is determined as above. As the cobalt is entirely separated before the oxidation of the chrome begins, the current should be interrupted after its deposition, as it may otherwise be redissolved by the ammonium hydrocarbonate.

Separation of Cobalt from Chromium and Manganese.—After the separation of the chrome the solution is further electrolyzed for the decomposition of the oxalic acid and the peroxidation of the chrome, and is then boiled for some time. Hydrogen peroxide or bromine water is then added; the liquid is rendered alkaline with potassa, and the manganese is determined as sulphate or as manganomanganic oxide. The filtrate is then treated as in the separation of zinc from chrome.—*Berichte der Deutschen Chemischen Gesellschaft.*—*Chem. News.*

ON THE CHANGES PRODUCED BY MAGNETIZATION IN THE LENGTH OF RODS OF IRON, STEEL, AND NICKEL.*

By SHELFORD BIDWELL, M.A., LL.B.

THE earliest systematic experiments on the effects produced by magnetization upon the length of iron and steel bars are those of Joule, an account of which is published in the *Phil. Mag.* of 1847. Joule's experiments have been many times repeated, and his general results confirmed. In particular, Prof. A. M. Mayer carried out a series of very careful observations with apparatus of elaborate construction and great delicacy. The conclusions at which he arrived were in accord with those of Joule, so far as regards iron; in the case of steel there was some apparent discrepancy, which, however, might to a great extent be accounted for by differences in the quality of the metal used and in the manner of conducting the experiments. In 1882 Prof. Barrett published in *Nature* an account of some experiments which he had made, not only on iron, but also on bars of nickel and cobalt, with a view of ascertaining the effect of magnetization upon their length.

The knowledge on the subject up to the present time may be summarized as follows:

(1.) Magnetization causes in iron bars an elongation, the amount of which varies up to a certain point as the square of the magnetizing force. When the saturation point is approached, the elongation is less than this law would require. The effect is greater in proportion to the softness of the metal.

(2.) When a rod or wire of iron is stretched by a weight, the elongating effect of magnetization is diminished; and if the ratio of the weight to the section of the wire exceeds a certain limit, magnetization causes retraction instead of elongation.

(3.) Soft steel behaves like iron, but the elongation for a given magnetizing force is smaller (Joule). Hard steel is slightly elongated, both when the magnetizing current is made and when it is interrupted, provided that the strength of the successive currents is gradually increased (Joule). The first application of the magnetizing force causes elongation of a steel bar if it is tempered blue, and retraction if it is tempered yellow; subsequent applications of the *same* external magnetizing force cause temporary retraction, whether the temper of the steel is blue or yellow (Mayer).

(4.) The length of a nickel bar is diminished by magnetization, the maximum retraction being twice as great as the maximum elongation of iron (Barrett).

In order that the results of Joule and Mayer might be comparable with those obtained by the author, he made an attempt to estimate the magnetizing forces with which they worked. From data contained in their paper, it was calculated that the strongest magnetizing force used by Joule was about 126 units, while the strongest used by Mayer did not on the highest probable estimate exceed 118 units. In the author's experiments the magnetizing force was carried up to about 312 units. The metal rods, too, were much smaller than any which had been before used for the purpose, ranging in diameter from 1·40 to 6·25 mm. Their length was in every case 100 mm., and the apparatus was capable of measuring with tolerable certainty an elongation or retraction equal to a ten millionth part of this length.

By using thinner iron rods and greater magnetizing forces than those previously employed, the following curious and interesting fact was established: If the magnetization be carried beyond a certain critical point, the consequent elongation, instead of remaining stationary at a maximum, becomes diminished, the diminution increasing with the magnetizing force. If the force is sufficiently increased, a point is arrived at where the original length of the rod is totally unaffected by magnetization; and if the magnetization be carried still further, the original length of the rod will be reduced. It also appeared that the position of the critical point in steel depended in a very remarkable manner upon the hardness or temper of the metal; considerable light is thus thrown on the apparently anomalous results obtained by Joule and by Mayer. Further experiments disclosed strong reason for believing that the value of the critical magnetizing force in a thin iron rod was greatly reduced by stretching; this would explain the fact that Joule obtained opposite effects with stretched and unstretched wires.

By ascertaining the relative values of the temporary moments induced by gradually increasing external magnetizing forces, an attempt was made to connect the point of maximum elongation with a definite phase of the magnetization of the several rods in which the elongation had been observed.

Though more experiments must be made before it is possible to generalize from them with perfect safety, the results so far obtained by the author indicate the laws given below. The elongations and magnetizations referred to are temporary only; before the beginning of an experiment, the rod was permanently magnetized by passing through the magnetizing coil a current equal to the strongest subsequently used. In iron the greatest elongation due to permanent magnetization was generally found to be about one-third of the total elongation, while in nickel the permanent retraction amounted only to about one twenty-fifth part of the whole.

I. IRON.

(1.) The length of an iron rod is increased by magnetization up to a certain critical value of the magnetizing force, when a maximum elongation is reached.

(2.) If the critical value of the magnetizing force is exceeded, the elongation is diminished until, with a sufficiently powerful magnetizing force, the original length of the rod is unaffected, and, if the force is still further increased, the rod undergoes retraction. Shortly after the critical point is passed, the elongation diminishes in proportion as the magnetizing force increases. The greatest actual retraction hitherto observed was equal to about half the maximum elongation, but there was no indication of a limit, and a stronger magnetizing force would have produced further retraction.

(3.) The value of the external magnetizing force corresponding to maximum elongation is for a given rod approximately equal to twice its value at the "turning point."

Definition.—The turning point in the magnetization of an iron bar is reached when the temporary moment begins to increase less rapidly than the external magnetizing force.

(4.) The external force corresponding to the point of maximum elongation increases (when the quality of the iron is the same) with the diameter of the rod. So also does its value at the turning point.

(5.) The amount of the maximum elongation appears to vary inversely as the square root of the diameter of the rod, when the quality of the iron is the same.

(6.) The turning point, and therefore presumably the point of maximum elongation, occurs with a smaller magnetizing force when the rod is stretched than when it is unstretched.

II. STEEL.

(7.) In soft steel magnetization produces elongation, which, as in the case of iron, increases up to a certain value of the magnetizing force, and afterward diminishes. The maximum elongation is less than in iron, and the rate of diminution after the maximum is passed is also less.

(8.) The critical value of the magnetizing force for a steel rod diminishes with increasing hardness up to a certain point, corresponding to a yellow temper; after which it increases, and with very hard steel becomes very high. There is therefore a critical degree of hardness for which the critical magnetizing force is a minimum; in steel of a yellow temper the value of the critical magnetizing force is lower than in steel which is either softer or harder.

(9.) In soft steel a strong magnetizing force subsequently diminished may cause a greater temporary elongation than the diminished force is capable of producing if applied in the first place.

(10.) A temporary elongation when once produced in soft steel may be maintained by a magnetizing force which is itself too small to originate any perceptible elongation.

III. NICKEL.

(11.) Nickel continues to retract with magnetizing forces far exceeding those which produce the maximum elongation of iron. The greatest observed retraction of nickel is more than three times the maximum observed elongation of iron, and the limit has not yet been reached.

(12.) A nickel wire stretched by a weight undergoes retraction when magnetized.

* Royal Society, April 23.

THE RESOURCES OF ALASKA.

By FREDERICK SCHWATKA.

THIS distant colony of ours is now in that transition state where, having advanced far enough to know that it has valuable resources, it has not gotten so far that interested immigration associations and semi-organized financial adventure are pressing the coming citizen and capitalist to look at these industries through the microscope of their circulars. This latter fact may be due to the influence of powerful corporations with fixed monopolies producing government apathy, so that no government at all existed until last year on which the minor industries could found a basis for existence. Alaska is square shaped, with two horns projecting from the southeast and southwest corners, the former called Southeastern Alaska, the latter being the Aleutian Islands. This southeastern horn is the place where is congregated nearly all the white population engaged in those industries over which the government has thrown no special protection.

Nearly all of Alaska south of the Arctic Circle may be said to be well covered with timber, except an immaterial portion facing Behring Sea and the Aleutian Islands, although in the broadest sense none of it is fit for more than local use except Southeastern Alaska, and most of this, from its remoteness, can never expect to compete with the more valuable and vast timber fields of British Columbia, Oregon, and Washington Territory until, in the far future, the latter are exhausted. There is one exception to this general rule, however, in a very valuable kind of timber found near the tip of the southeastern horn, and extending into British Columbia along the Pacific coast. I refer to the yellow cedar of Alaskan parlance, *Cupressus nutkanensis* of scientists. For a number of years it has been used on the northwest coast as a "fancy wood," from its exceeding fine, hard texture, great durability, an odor which, though agreeable to the *genus homo*, is a sure preventive to moths, and other good qualities for cabinet making, special wood work, and so on. The yellow cedar attains enormous size compared with the dwarfed species by which it is surrounded, often reaching a height of over a hundred feet and corresponding diameter at the butt, shown by the conifer family. When I was in Boca de Quadra Inlet, Alaska, not far from Dixon Entrance, that separates this territory from British Columbia, we had to unload sixty-five tons of freight at a salmon cannery there, and this was done in two loads by a raft made of two logs of yellow cedar not yet thoroughly seasoned. I thought they were ten feet at the butt, so grand were the logs, but probably two-thirds that would be about the truth. Even in the region that this extremely valuable tree occupies—the lower third of Southeastern Alaska—it is not found in large districts, either in compact forests or straggling cases among other kinds, but rather in little isolated groups or patches here and there, ten acre and hundred acre lots, so to speak; but once found, this patch is quite densely populated with them. This would really be greatly in its favor in securing these "groups" as timber land. Some of them, however, are quite large, and many have never been well outlined, and others, no doubt, are yet to be discovered in this almost wild country. Most of it grows near the water, and this phase in an Alpine country cut up by numberless channels and inlets of water running in every direction and creating thousands of islands may be readily appreciated. Near by the old Russian towns the clumps have been exterminated by them before we came in possession of Russian America; and had they held it, I have but little doubt it would now be worked on a large scale, or monopolized by some Muscovite favorites. While living in Oregon and the adjacent Territories, I often heard these valuable fields of timber discussed by parties who desired some law to protect them in securing them, and I was more than impressed with their sayings when I afterward visited the districts.

Our present financial depression, with capital seeking no new ventures, falling just as Alaska was given some form of law, and the probability that no surveys or methods of getting at these districts even in the rough law applied, has probably left these yellow cedar fields in much the same status as the past. I look on the industry based on this timber as one of the future "bonanzas" of Alaska, and the only one in the line of timber.

I have spoken of a salmon cannery in Bocade Quadra Inlet, and may add that a number of these industries are scattered here and there in the southeastern horn. They seem to be growing in numbers steadily, which would indicate prosperity. They are graded below Columbia River salmon in quality and price, but the cost of catching is so much less that I think they make more per case, over 20,000 cases having been shipped in 1883. These waters swarm with salmon during the summer, and the main objection against the industry in this district is the inferior quality of fish compared with those of Oregon, which will always be against very high profits, however cheap they may be able to get the fish.

As the data to the salmon industry is more accessible in this part of Alaska, I will pass, with the above few remarks, to a district where much less is known, and where, I think, the prospects are much better. I refer to the large rivers of Alaska, and especially those emptying into Behring's Sea, the Yukon, Koskoquim, and others, whose waters have not even been prospect-

ed with this idea in view. From the fact that all the important salmon canneries of the Pacific coast are on the larger rivers, the Fraser of British Columbia, the Columbia of Oregon and Washington, and the Sacramento of California, while none worthy of mention exist on the smaller streams, the same might have been inferred in Alaska, and thus drawn attention to these rivers, even if they were so remote and apparently inaccessible. I descended the Yukon River its whole length, 2,045 miles, in 1883. At 2,000 miles from its mouth, salmon commence appearing in sufficient quantities to enable the Indians to live upon them in the summer, while running, and put by a small quantity, smoked and dried, for later use. The amount thus preserved steadily increases as one descends the great river, and as the natives increase in numbers, until at about 500 or 600 miles from the mouth to that point the natives live almost wholly upon fish the year round, besides feeding large numbers of their dogs upon them. The drying yards of the native fishermen on the lower river are simply acres in extent, and it seems folly to me to attempt to estimate the amount, except by allowing wide margins for approximation. One person roughly estimates the catch on the Alaskan rivers at 10,000,000. Allow half that to be correct, and we see that the amount annually taken from the Columbia--about 600,000 cases, three fish to the case—and which requires most rigid laws to prevent extermination, would have no appreciable effect on this great northern river, the Yukon.

There are very few white traders on the lower Yukon in the employ of the Alaska Commercial Company, who, keeping their own dogs, purchase salmon of the natives for their winter's maintenance. The natives catch them in traps and weirs, clean them, slice them longitudinally, so they will dry faster, put them on trellises to dry, store them away in their caches, and when winter comes on take them out, sledge them to the trader's store, and sell them for one cent apiece in trade, which means two or three mills! Transferring the Columbia River catch to the Yukon, with the difference of price in the fish, would show a saving of so much over a million dollars that the increased cost of canneries, shipping to and from, etc., would not lower it much below that sum to show as clean profit over that on the Columbia. I saw at least a half dozen fine sites near the mouth of the Yukon, fulfilling all requirements demanded by a canning establishment, as far as water, wood, and minor accessories are concerned, a number that could undoubtedly be increased by a person searching with that object in view. The best quality of the Yukon River salmon is said to excel the Chinook salmon of the Columbia River, and so I thought when there; but am willing to acknowledge that a person just ending a long exploration on the roughest fare may not be in the best condition to judge, and may be conscientiously deceived. I believe the best variety is called the "king salmon," with a pinkish, firm, hard meat, and weighing double the Chinook of the Columbia. They comprise, roughly estimating, about one-fifth of the catch of the natives, who treat them the same as the others; one variety, however, the dog salmon, being fed only to their dogs, except in cases where they are pinched for food. The king salmon catch, therefore, could be made equal to that of the Columbia River, giving the other secured to the natives who would be employed as fishermen. Another variety, however, comprising about two-fifths of the native catch, locally known as "red back," I believe, are claimed to equal the Chinook salmon, but I am inclined to think they might be graded a little lower.

The Roskoquim, south of the Yukon, and the Kowak, north of it, are large rivers also, and said to be as good in salmon canning prospects as the Yukon, although I never personally visited them. I feel confident that the salmon fisheries of Alaska, in their entirety, the merest portion of which has been invaded so far, are as superior to those of the northwest of the United States proper as they are superior to those of California; or, in short, that they are the most important in the world. I might say, in closing the salmon subject, that the mouths of all the Alaskan streams emptying into Behring's Sea, which is very shallow on its eastern shores, have built up ugly bars with river sediment, and these must be noticed in calculations about commerce with any industry on the streams themselves. None of them are fatal, however, to such schemes, but simply hinderances of greater or less magnitude to be overcome.

The whale fishery of Alaskan bays and contiguous waters is just the reverse of the salmon fishery, in the knowledge of it by the public; that is, its most important whaling grounds are well known and thoroughly invaded, yielding us an average income of about $1,000,000 per year. All data and statistics of the North Pacific whaling fleet can be so easily procured in San Francisco that I will not follow them up, but in dropping the subject I should say there is getting to be a tendency to establish whaling stations along the Alaskan coast, which by the utilization of natives as whalemen allows small capital to enter this field, heretofore held only by those who could fit out ships. Whales were caught for their oil at Killisnoo, Southeastern Alaska, and found profitable, but experiments with other fisheries set them to making herring oil and drying codfish, where from 2,500 to 5,000 cases are annually turned out, of a quality said to be superior in every way to that of the East. In its cod fisheries Alaska is undoubtedly destined to lead the world, if supply and accessibility are worth anything in computation. I have spoken of the shallow shores of eastern Behring's Sea, and these submarine plateaus, the largest in the world, extend in almost every direction from Alaska's shores, and simply swarm with codfish. To compare them with the Atlantic banks would be like comparing the population of China with that of the Hudson Bay territory; none of them would make a coupon to the cod banks of Alaska. Some of the Alaskan natives live on these fish the year round, mixing them, singularly enough, with the dwarfed potatoes they raise in little patches. The Shumagin Island banks are the favorite ones, and from here they extend westward to nearly 170° west longitude (as now located, but probably beyond) into the Arctic until navigation becomes unsafe, and to British Columbia on the south. On the Shumagin Islands an infant industry is established, on a small scale, catching about 1,000,000 a year with but little over a half dozen men, their daily catch per man being 200 or 300 cod, while double that number are often secured. The fish are taken to San Francisco to be cured, and this degrades their quality, a process that more wholesale methods of dealing would obviate. The only element now against the Alaskan cod banks is the demand, which has heretofore been only the Pacific coast, and that in a very restricted sense. With the competition of the Northern and Canadian Pacific, and projected roads to the Northwest, and the resumption of business prosperity, it is probable that this industry may share some of the latter. While there never will be a "bonanza" in the cod fisheries that is probable in the salmon of the Yukon, and the cedar of the southeastern horn, it will always be the cornerstone of Alaska's wealth, when the population of the Pacific or cheap transportation eastward creates a demand for it.

One resource of Alaska that will always be a constant revenue to that territory, or those putting money into it, directly or indirectly, is to be found in its grand and easily accessible scenery of the southeastern part. For over a thousand miles from Olympia, Washington Territory, to Chilkat, Alaska, the tourist sails on the ocean, which, protected by the innumerable islands off this coast, becomes really a huge salt water river of that length, as quiet as a mill pond, be there a gale or a calm. The scenery is of the boldest Alpine character in these canal-like fjords, with just enough variety to prevent monotony on such a long tour. In fact, it is especially adapted to those tourists who for any reason are averse to physical exertion or seasickness, and it will not be many decades before the traveler who has not seen the inland passage to Alaska will not be considered as having his education of sightseeing complete.

The fisheries of fur in Alaska have been, are now, and may always be the most important resource of that country, taken directly from the land itself, although the catch of sea-otters could hardly be so classed. As probably every one knows, the fur-seal fishery of the Pribylov group of islands (St. George and St. Paul), generally known with us by the name of "Seal Islands," is the most important. As more is known regarding this particular industry financially, or, better speaking, is supposed to be known, and as its entire profits are monopolized by a corporation having exclusive powers to kill these animals on the Seal Islands until the year 1890, I will pass to the fur fisheries, where less is generally known, and over which the government has thrown no special protection. Principally among the latter we find the sea-otter catch, with an annual output of about five thousand, representing a half million dollars in the wholesale market, and, as usual with fancy furs, many times more by the time it reaches the hands of the last purchaser. The sea-otter extends along the southern boundary of Alaska from tip to tip of the two horns, although about the center of the extended group of the Aleutian Islands they seem to be the thickest, nearly half the annual catch being taken here within a radius that would be visible from the top of one of the hills of the central islands. Just at present the Alaska Commercial Company, leasing the Seal Islands, nearly monopolize the sea-otter catch, for the simple reason that no enterprise can be carried on in western Alaska unless it can secure sufficient capital to fit out a vessel, however small and short the time employed. The sea-otter catch of Alaska is worth more than half that of all other furs put together (the fur seals being excluded), after that the others coming in their order of value of catch, being marten (sable), black fox, beaver, red fox, cross fox, land otter, blue fox, mink, lynx, white fox, brown bear, muskrat, black bear, and wolf. Could cheap transportation be gotten to Alaska for that once numerous class of Western trappers, now mostly out of employment from their fields of operation having been obliterated by the encroachments of the more useful industries of civilization, and the repeal of an obnoxious law which prohibits a white man from directly taking fur-bearing animals in Alaska—a law made wholly in the interests of a single corporation—it is evident that the annual catch could be doubled and the money accruing therefrom distributed among many instead of one or two close monopolies. I understand from good authority that the present steamer lines may pass into hands that will make this possible, or at least nearer than it has ever attained. I might add also, in closing this subject, that the sea-otter fisheries are "worked for all they are worth," and any greater destruction would put them on the downward way to extinction—certainly in a financial sense.

For the small amount of Alaska that has been explored by those able to judge of its mineral capacities it might be truly said that the prospect of its taking rank among the mineral-bearing territories can be said to be fair at least. Until very recently people were prohibited from legally gaining any rights to mineral lands, and consequently those "prospects" that were good, but needed further verification to solicit capital, were legally strangled at once, if that verification called for an outlay of money. The law so recently thrown over Alaska coming on the same wave with the present financial depression, it is hardly fair to judge what good it may do until the latter is well past. On Douglas Island, in the southeastern horn, mines have been discovered of sufficient importance to build up the largest town in Alaska, Juneau, although of that floating character that is hardly fair to give it this reputation. One mine here is said to have the largest quartz mill in the world—120 stamps—while $16,000,000 has been declined for it, owing to the prospects in sight. Anyone at all familiar with the character of the country in southeastern Alaska, and knowing that even a single productive mine had been found, might well hope that it was not an isolated case, for in no place in the world is prospecting carried on with greater difficulties. The steep, mountainous country, standing almost "on end," so to speak, is covered with a dense, almost tropical, jungle of forests and vegetation even on the steepest inclines, and these have been accumulating for years, apparently never rotting, until the labor of reaching the ground for prospecting purposes becomes a work that Hercules would sub-let. Indians, it is said, took the prospectors to the Treadwell mine near Juneau, referred to above, or it might have remained a secret for another century, as probably hundreds of others might, as they certainly could, be hidden even from the keen eyes of the natives. Occasionally an avalanche sweeping down the steep mountain sides lays bare a broad swath of land that can be examined, but otherwise, unless gold-bearing float or other indications point to very circumscribed localities, prospecting in southeastern Alaska is most discouraging. The Treadwell ore is gold-bearing and is a light-tinted quartz, crushing easily. Many other less satisfactory mines exist in this district, but as they are all near the little settlements, not previously determined by their existence, it is fair to presume that many valuable mines are yet hidden in the less accessible parts; in fact, for the reasons given above, they may exist "under their very noses," for all they would know until they stumbled on them. Attempting to get inland in this part of Alaska is almost out of the question, as even the Indians seldom essay it for any purpose, owing to the obstacles named. That even these obstacles may be overcome in the not far future is very likely in the light of the past when gold is the inducement. When I crossed over to the head of the Yukon River through a pass in the Alaska coast range of mountains, I knew that prospectors had preceded me, but with what luck was unknown. This river, the Yukon, is 2,045 miles long. About 1,700 miles from its mouth, where a large affluent, the D'Abbadie River, comes in from the east, prospects of gold commence and last in varying amounts almost to the mouth of the river. I afterward ascertained that miners had gone up the D'Abbadie River 200 miles prospecting. Everywhere we found gold that gave ten to twelve "colors to the pan." Sometimes at the mouth of an incoming stream or in other favorable places it would amount to twenty "colors," and sometimes sink to three or four, but it seemed to exist everywhere, but in no place could it be traced to much better prospects. To the very head of the D'Abbadie it was the same, and one miner I afterward met, who had been in on this part of the river, said that this widespread diffusion of fine gold could even be traced up the sides of the steep hills. The Pelly River, a large tributary of the Yukon from the east, and about 1,500 miles from its mouth, is the only tributary of the great river where miners have found placer gold in paying quantities, and even this can only be inferred from their returning from year to year to work on this stream, the amounts they realize being unknown to the outside world. It certainly seems as if a concentration of the precious mineral could be found at some point or points, where so much was scattered over such a vast tract of country. The Rocky Mountain divide, with its gold-bearing belt, after reaching about sixty-three or four north latitude sweeps westward, crossing the Yukon along the "Upper Ramparts," and becomes the Alaskan range of mountains, finally fading away to the westward in the Aleutian chain of mountains. Where the Yukon cuts through, signs of mineral become a little more numerous. The Tanana, an immense tributary of the Yukon, probably a thousand miles in length and wholly unexplored, sweeps, according to Indian reports, along the foot-hills of this range, further westward, sending many little streams into the mountains themselves, and offering, I believe, from all the surrounding circumstances, the best field for prospecting in Alaska. It could be reached by descending the Yukon as I did in 1883. The current of the Tanana is very swift, a great obstacle in ascending it, but assuring a good deposition of placer gold if there be any. The Indians near the boundary, however, say they know a trail that leads to its head. The Scheffelin brothers prospected the lower Yukon the year I was upon it (1883), and I understood from the elder brother, the discoverer of the Tombstone mines of Arizona, that he found ounce diggings on the Melozecargut, that might well pay individual enterprise, but would not suffice for extended capital. Gold-bearing deposits on the Kenai peninsula were once claimed by the Russians, but they never seem to have met all expectations since.

Argentiferous galena mines have been worked in Golovin Bay, on the north shore of Norton Sound, and when I was near there in September, 1883, a sailing vessel, the Alaska, was loading with this ore for San Francisco. It was said to assay $57 to the ton, and the supply seemed good. I afterward was told that the Alaska had never been heard from since. When at St. Michael's, on the southern side of Norton Sound, I was informed by an employe of the Alaska Company that the natives had shown him specimens of the same kind of ore taken somewhere between Golovin Bay and Unalachleet, and told him the supply was inexhaustible, they having become familiar with the ore by seeing it often at the Golovin mines, where they had been. I heard the story corroborated verbally, but never saw any of the specimens, which, I might add, I considered in its favor; for, had the report been a "put up job," Golovin Bay specimens, easy to secure, would no doubt have accompanied it.

Native copper for years has been brought down the Copper or Atna River of Alaska by the Indians, and from here found its way to many white people in the way of trade, and so on. The Copper River is not navigable, except in stretches, being full of rapids, falls, etc., by Indian reports at one place a glacier jutting into the stream. So far the Indians have prevented the whites from entering this valley far, and have refused to disclose the whereabouts of the mine. The river is said by them to have two principal forks, and each one heads in a lake. When I was upon the Yukon River, I was shown specimens of copper ore taken from the valley near the boundary, which at once indicated good azurite, or the blue carbonate of copper. It came from quite an extensive ledge cropping out. All the rest that is known concerning it is from Indian reports, but agree so well with what would be expected that I give them. This bluestone, they say, crops out here and there for a distance inland equal to a day or two's journey in the winter with dogs and sledge, or probably twenty to thirty miles; they then have the same appearance of a reddish stone for a like distance, and then they come to a lake in the mountains, where is found native copper in sheets, and where they get enough for arrow-heads, although they seldom visit it, owing to hostile Indians living about it. Geologically their reports agree well with facts. In the mountainous country, where igneous action has been at work since the copper was deposited, it has been smelted by natural operations, and appears in sheets as native copper, while the azurite or blue carbonate is in its original form of deposition, while half way between the heat, though not great enough to smelt, has driven away an equivalent of carbonic acid, leaving it as cuprite, or red oxide. If the deposits are anything near like the dimensions given by the Indians, this copper field must rival any district now known of that mineral. The Yukon is navigable well past this district, and large

quantities of Sitka spruce cover the country near it, from which coke could be made for smelting, while coal exists on the river a little lower down, though not tested.

Agriculturally, Alaska is poor, though hardy vegetables by extra care can be raised in some parts sufficient for local consumption, although, if other industries open lines of transportation, they too will be imported by them.

Stock-raising, however, seems perfectly feasible in most of the Aleutian Islands, and were it not for the mosquitoes, other districts could be named for hardy breeds. The advantages of the Aleutian Islands are the monopoly of ranges without fencing, and advantages of assorting where there are many islands, the needlessness of branding, the abolishing of "round-ups," etc. The climate of this chain is phenomenal for so high a latitude, the coldest weather ever recorded—about fifty years go—being two degrees above zero, and since the United States has had it, six degrees above was the coldest noted at any United States signal station upon them. The islands are covered with a perfect network of little streams, so that stock would have no great distance to travel to water, a cause of tough beef. Luxurious grasses grow in the valleys up to one's knees, while the rolling hills are covered with a shorter bunch grass up to 2,000 feet above the sea-level. During the shipping season in the summer and fall a steady northwest wind can be depended upon, materially assisting shipments to the United States ports lower down. I might add in closing that a very few cattle kept here for milk and butter by white people, employes of the Alaska Company, were in conspicuously fine condition in September. Of course, a company must be large enough to control its own ships, etc., which would practically bar small capital from operating, at least until friendly larger companies had first started.—*Bradstreet's.*

A KING'S GRAVE IN CABINDA, WEST AFRICA.

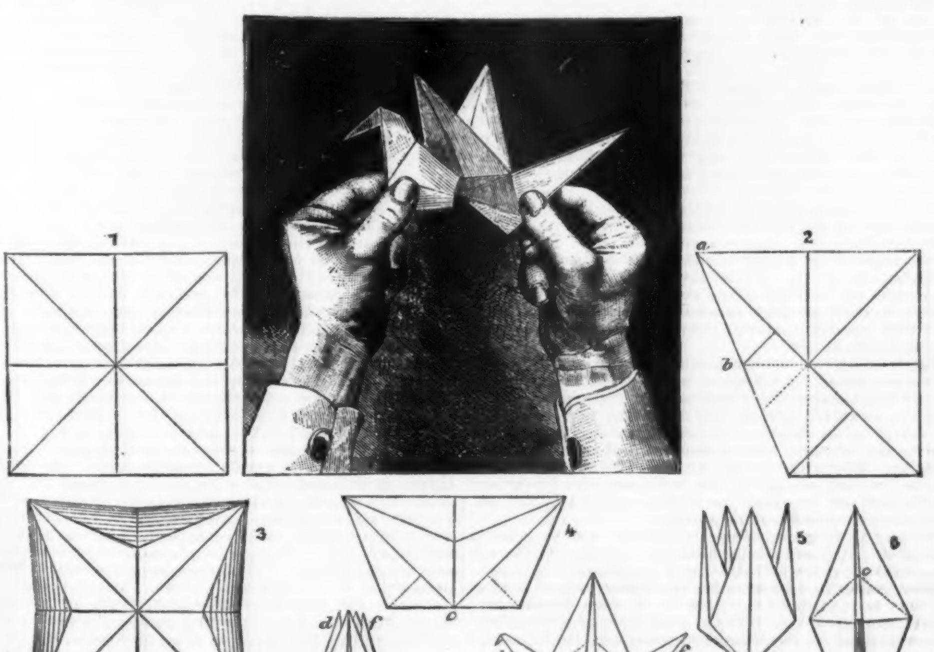
HANS PETERSEN writes as follows in the *Illustrirte Zeitung:*

By passing down the Kwilo River, the Loango, and the Lendana, Cabinda, is reached. This is the residence of King Fine, who is a rather talkative gentleman. He received us in an old uniform of a Spanish admiral, minus the trousers, which were replaced by an apron, and with him we visited the graves of his ancestors and predecessors. Whenever a celebrated person of the tribe dies, the corpse is wrapped in a large quantity of thin fabric and placed in a large and high wagon of very rude construction, and having the appearance of a cage. In this wagon the body is kept for a number of years before it is buried. The wagon is then drawn to the grave, which is about thirty feet deep. The mourners drink enormous quantities of gin, waste much powder, and the corpse is placed in the grave. The gin bottles emptied in honor of the departed and the empty powder barrels remain on the grave as an indication of the greatness of the man who was buried there.

A KING'S GRAVE IN CABINDA.

A MECHANICAL BIRD MADE OF PAPER.

THE object which we propose to describe, and which is due to Japanese digitatus, is a paper bird that is capable of flapping its wings when it is properly actuated with the hands. The engraving in the center represents the object in operation, and the diagrams that surround it show the mode of manufacture.



A MECHANICAL PAPER BIRD.

Take a sheet of letter paper, and cut it so that it shall be about five inches square. Fold this sheet through the middle and angles so as to form the creases shown in Fig. 1. This done, fold the corners over as shown in Fig. 2, and form a crease from *a* to *b* only; and then proceed in the same way with the two sides of the other corners in succession. The paper will then have the appearance shown in Fig. 3. Next, fold the paper successively in both directions, as shown in Fig. 4. The object of this operation is to perfect the creases. It will then be easy, in forming creases around the center, *c*, to pass from this figure to Fig. 5. This once effected, turn the paper over so that the angle, *c*, shall be situated at the upper part, and the four points beneath; and then, in the same way, pull out to the right and left the points remaining at the lower part, so as to obtain the form shown in Fig. 7. Upon pulling out the points, *d* and *f*, to the right and left, we shall have the bird shown in Fig. 8. The head of the bird is made by folding the point, *d*, over. On taking hold of this paper bird by the points, *m* and *n*, and causing these latter to successively approach and recede, a flapping of the wings is produced. The same motion may be obtained by grasping the bird at the point, *m*, and pulling the tail, *f*.—*La Nature.*

QUITO, ECUADOR.

THE population of Ecuador is about a million, and the nation owes twenty gold dollars per capita for every one of the inhabitants. Three hundred thousand of the population are of Spanish descent, 100,000 are foreigners, and 600,000 native Indians or persons of mixed blood. A correspondent of the N. Y. *Sun* says: The commerce is in the hands of the foreigners entirely, and thus have a mortgage upon the entire country. The Indians are the only people who work. Over the doors of the residences or the business houses, and both are usually under the same roof, are signs reading: "This is the property of an Englishman," "This is the property of a citizen of Germany," and so on, a necessary warning to revolutionists, who are thus notified to keep their hands off.

The Spaniards are the aristocracy, poor but proud, very proud. The mixed race furnishes the mechanics and artisans, while the Indians till the soil and do the drudgery. A cook gets $2 a month in a depreciated currency, but the employer is expected to board her entire family. A laborer gets $4 or $6 a month and boards himself, except when he is fortunate enough to have a wife out at service. The Indians never marry, because they cannot afford to. The law compels him to pay the priest a fee of $6, more money than most of them can ever accumulate. When a Spaniard marries, the fee is paid by contributions from his relatives.

Although the road to Quito is over an almost untrodden wilderness, it presents the grandest scenic panorama in the world. Directly beneath the equator, surrounding the city whose origin is lost in the mist of centuries, rise twenty volcanoes, presided over by the princely Chimborazo, the lowest being 15,922 feet in height, and the highest reaching an altitude of 22,500 feet. Three of these volcanoes are active, five are dormant, and twelve extinct. Nowhere else on the earth's surface is such a cluster of peaks, such a grand assemblage of giants. Eighteen of the twenty are covered with perpetual snow, and the summits of eleven have never been reached by a living creature except the condor, whose flight surpasses that of any other bird. At noon the vertical sun throws a profusion of light upon the snow-crowned summits, where they appear like a group of pyramids cut in spotless marble.

Cotopaxi is the loftiest of active volcanoes, but it is slumbering now. The only evidence of action is the frequent rumblings, which can be heard for a hundred miles, and the cloud of smoke by day and the pillar of fire by night which constantly arise from a crater that is more than 3,000 feet beyond the reach of man. Many have attempted to scale it, but the walls are so steep and the snow is so deep that ascent is impossible, even with scaling ladders. On the south side of Cotopaxi is a great rock, more than 2,000 feet high, called the "Inca's Head." Tradition says that it was once the summit of the volcano, and fell on the day when Atahualpa was strangled by the Spaniards. Those who have seen Vesuvius can judge of the grandeur of Cotopaxi, if they can imagine a volcano 15,000 feet higher shooting forth its fire from a crest covered by 3,000 feet of snow, with a voice that has been heard six hundred miles. And one can judge of the grandeur of the road

to Quito if he can imagine twenty of the highest mountains in America, three of them active volcanoes, standing along the road from Washington to New York.

Here in these mountains, until the Spaniards came in 1534, existed a civilization that was old when Christ was crucified; a civilization whose arts were equal to those of Egypt; which had temples four times the size of the Capitol at Washington, from a single one of which the Spaniards drew out 22,000 ounces of solid silver nails; whose rulers had palaces from which the Spaniards gathered 90,000 ounces of gold and an unmeasured quantity of silver. Here was an empire stretching from the equator to the antarctic circle, walled in by the grandest groups of mountains in the world, whose people knew all the arts of their time but those of war, and were conquered by 213 men under the leadership of a Spanish swineherd who could neither read nor write.

ON THE AGENCY OF WATER IN VOLCANIC ERUPTIONS, WITH SOME OBSERVATIONS ON THE THICKNESS OF THE EARTH'S CRUST FROM A GEOLOGICAL POINT OF VIEW, AND ON THE PRIMARY CAUSE OF VOLCANIC ACTION.*

By JOSEPH PRESTWICH, F.R.S., Professor of Geology in the University of Oxford.

THAT water plays an important part in volcanic eruptions is a well-established fact, but there is a difference of opinion as to whether it should be regarded as a primary or a secondary agent, and as to the time, place, and mode of its intervention. The author gives the opinions of Daubeny, Poulett Scrope, and Mallet, and, dismissing the first and last as not meeting the views of geologists, proceeds to examine the grounds of Scrope's hypothesis—the one generally accepted in this country—which holds that the rise of lava in a volcanic vent is occasioned by the expansion of volumes of high pressure steam generated in the interior of a mass of liquefied and heated mineral matter within or beneath the eruptive orifice, or that volcanic eruptions are to be attributed to the escape of high pressure steam existing in the interior of the earth. The way in which the water is introduced and where is not explained, but as the expulsion of the lava is considered to be due to the force of the imprisoned vapor, it is, of course, necessary that it should extend to the very base of the volcanic foci, just as it is necessary that the powder must be in the breech of the gun to effect the expulsion of the ball.

The author then proceeds to state his objections to this hypothesis. In the first place, he questions whether it is possible for water to penetrate to a heated or molten magma underlying the solid crust. The stratigraphical difficulties are not insurmountable, although it is well known that the quantity of water within the depths actually reached in mines decreases, as a rule, with the depth, and is less in the Palæozoic than in the Mesozoic and Kainozoic strata.

The main difficulty is thermo-dynamical. As the elastic vapor of water increases with the rise of temperature, and faster at high than at low temperatures, the pressure—which at a depth of about 7,500 feet and with a temperature (taking the thermometric gradient at 48 feet per 1° F.) of 212° F. would be equal to that of one atmosphere only—would at a depth of 15,000 feet and a temperature of 362° be equal to 10½ atmospheres, and at 20,000 feet and temperature of 467° would exceed 25 atmospheres. Beyond this temperature the pressure has only been determined by empirical formulæ, which, as the increase of pressure is nearly proportional to the fifth power of the excess of temperature, would show that the pressure, in presence of the heat at greater depths, becomes excessive. Thus, if the formulæ hold good to the critical point of water, or 773°, there would at that temperature be a pressure of about 350 atmospheres.

At temperatures exceeding 1,000° F. and depth of about 50,000 feet, the experiments of M. H. St. Claire Deville have shown that the vapor of water, under certain conditions, probably undergoes dissociation, and, consequently, a large increase in volume. It would follow also on this that if the water-vapor had been subject to the long-continued action of the high temperatures of great depths, we might expect to meet with a less amount of steam and a larger proportion of its constituent gases than occurs in the eruptions. Capillarity will assist the descent, and pressure will cause the water to retain its fluidity to considerable depths, but with the increasing heat capillarity loses its power.

Taking these various conditions into consideration, the author doubts whether the surface-waters can penetrate to depths of more than seven to eight miles, and feels it impossible to accept any hypothesis based upon an assumed percolation to unlimited depths. That there should be open fissures through which water could penetrate to the volcanic foci, he also considers an impossibility.

But the objection to which the author attaches most weight against the extravasation of the lava being due to the presence of vapor in the volcanic foci is that, if such were the case, there should be a distinct relation between the discharge of the lava and of the vapor, whereas the result of an examination of a number of well-recorded eruptions shows that the two operations are in no relation, and are perfectly independent. Sometimes there has been a large discharge of lava and little or no escape of steam, and at other times there have been paroxysmal explosive eruptions with little discharge of lava.

There are instances in which the lava of Vesuvius has welled out almost with the tranquillity of a water-spring. A great eruption of Etna commenced with violent explosions and ejection of scoriæ, which, after sixteen days, ceased, but the flow of lava continued for four months without further explosions. In the eruption of Santorin, 1866, the rock-emission proceeded for days in silence, the protruded mass of lava forming a hill nearly 500 feet long by 200 feet high, which a witness compared with the steady and uninterrupted growth of a soap bubble. The eruptions of Mauna Loa are remarkable for their magnitude, and at the same time for their quiet. Speaking of the eruptions of 1855, Dana says there was no earthquake, no internal thunderings, and no premonitions. A vent or fissure was formed, from which a vast body of liquid lava flowed rapidly but quietly, and without steam explosions, for the space of many months.

On the other hand, paroxysmal eruptions are generally accompanied by earthquakes, and begin with one powerful burst, followed rapidly by a succession of explosions, and commonly with little extrusion of lava, although it is to be observed that a large quantity must be blown into scoriæ and lost in the ejections. Such was the eruption of Coseguina in 1835, and of Krakatoa in 1883. Sometimes in these paroxysmal eruptions there is absolutely no escape of lava, scoriæ alone being projected. A common feature in eruptions, and which indicates the termination of the crisis, is the stopping of the lava, though the gaseous explosions continue for some time with scarcely diminished energy.

There is thus no definite relation between the quantity of explosive gases and vapors and the quantity of lava. If the eruption of lava depended on the occluded vapor, it is not easy to see how there could be great flows without a large escape of vapor, or large volumes of vapor without lava. The extrusion of lava has been compared to the boiling over of a viscid substance in a vessel, but the cases are not analogous.

The only logical way in which it would seem possible for water to be present is on the hypothesis of Sterry Hunt, who supposes the molten magma to be a remelted mass of the earlier sedimentary strata, which had been originally subject to surface and meteoric action. But in the end the preceding objections apply equally to this view.

There is the further general objection to the presence of water in the molten magma, in that, were the extrusion of lava due to this cause, the extrusion of granite and other molten rocks (which do not, as a rule, lie so deep as the lava magma) should have been the first to feel its influence and to show its presence. Yet although water is present, it is in such small quantities that these rocks never exhibit the scoriaceous character which lava so commonly possesses.

Nor is lava always scoriaceous, as it should be if the hypothesis were correct. Many lavas are perfectly compact and free from vapor-cavities, and so also are especially most of the great sheets of lava (basalt) which welled out through fissures in late geological times. These vast fissure eruptions, which in India and America cover thousands of square miles, and are several thousand feet thick, seem conclusive against water agency, for they have welled out evidently in a state of great fluidity, with extremely little explosive accompaniments, and often without a trace of scoriæ mounds. The general presence of non-hydrated rocks and minerals is also incompatible with the permeation of water which the assumption involves.

It has been suggested by some writers that large subterranean cavities may exist at depths in which the vapor of water is stored under high pressure, but the author shows that such natural cavities are highly improbable in any rocks, and impossible in calcareous strata.

The author proceeds to account for the presence of the enormous quantity of the vapor of water, so constantly present in eruptions, and which, in one eruption of Etna, was estimated by Fouque to be equal to about 5,000,000 gallons in the twenty-four hours. He refers it to the surface-waters gaining access *during the eruptions* to the volcanic ducts either in the volcanic mountain itself or at comparatively moderate depths beneath. He describes how the springs and wells are influenced by volcanic outbursts. By some observers, these effects have been referred to the influence of dry and wet seasons, but there are so many recorded instances by competent witnesses as to leave little doubt of the fact. This was also the decision of the inquiry by the late Prof. Phillips, who asks: "Why is the drying up of the wells and springs an indication of coming disaster?"

The author then considers the hydro-geological condition of the underground waters. He points to the well-known fact that on the surface of volcanoes the whole of the rainfall disappears at once, and shows that when the mountain is at rest, the underground water must behave as in ordinary sedimentary strata. Therefore, the water will remain stored in the body of the mountain, in the interstices of the rocks and scoriæ, and in the many empty lava-tunnels and cavities. The level of this water will rise with the height of the mountain, and he estimates that it has at times reached in Etna a height of 5,000 to 6,000 feet, while the permanent level of the springs at the base of the mountain seems to be at about 2,000 feet. The water does not, however, form one common reservoir, but is divided into a number of independent levels by the irregular distribution of the scoriæ, lava, etc. These beds are traversed by vertical dikes running radially from the crater, so that, as they generally admit of the passage of water, the dikes serve as conduits to carry the water to the central duct.

Little is known of the sedimentary strata on which volcanoes stand. In Naples, however, an artesian well found them under the volcanic materials in usual succession, and with several water-bearing beds, from one of which, at a depth of 1,524 feet, a spring of water rose to the surface with a discharge of 440 gallons per minute. When in a state of rest, the surplus underground waters escape in the ordinary way by springs on the surface, or when the strata crop out in the sea, they then form submarine springs.

During an eruption these conditions are completely changed. The ascending lava, as it crashes through the solid plug formed during a lengthened period of repose, comes in contact with the water lodged around or, may be, in the duct, which is at once flashed into steam, and gives rise to explosions more or less violent. These explosions rend the mountain, and fresh fissures are formed which further serve to carry the water to the duct from which they proceed: or they may serve as channels for the sea-water to flood the crater, when, as in the case of Coseguina and Krakatoa, the volcano is near the sea-level. As the eruption continues, the water-stores immediately around the duct become exhausted, and then the water lodged in the more distant parts of the mountain rushes into supply the void, and the explosions are violent and prolonged according to the available volume of water in the volcanic beds. When this store is exhausted, the same process will go on with the underlying water-bearing sedimentary strata traversed by the volcanic duct.

The author gives diagrams showing the position of the water-levels *before, during,* and *after* eruption; and describes the manner in which, if the strata surrounding the duct and below the sea-level become exhausted, the efflux of the fresh water which passed out to sea through the permeable beds, when the inland waters stood at their normal height above the sea-level, these same beds will in their turn serve as channels for the sea-water to restore the lowered water-level inland. Thus, the ex-current channels which carried the land-waters into the sea-bed, and there formed, as they often do off the coasts of the Mediterranean, powerful fresh-water springs, now serve as channels for an in-current stream of sea-water, which, like the fresh water it replaces, passes into the volcanic duct. This agrees with the fact that fresh-water remains are common in many eruptions, and marine diatomaceous remains in others; also that the products of decomposition of sea-water are so abundant during and at the close of eruptions. With the fall of the water-levels, the available supply of water becomes exhausted, or the channels of communication impeded, and this continues until, with the ceasing of the extravasation of the lava, the eruption comes to an end.

The author then explains the way in which the water may gain access to the lava in the duct, notwithstanding heat and pressure. This he considers to be dependent upon the difference between the statical and the kinetical pressure of the column of lava on the sides of the duct. In the change from the one state to the other, when the lava begins to flow, and its lateral pressure is lessened, the equilibrium with the surrounding elastic high pressure vapor becomes destroyed, and the vapor forces its way into the ascending lava. As this proceeds, the heated water further from the duct, and held back by the pressure of the vapor, flashes into steam to supply its place. If that water should be lodged in the joints of the surrounding rock, blocks of it will also be blown off, driven into, and ejected with, the ascending lava, as have been the blocks in Somma and of other volcanoes.

It is the double action thus established between the inland and sea waters that has probably prolonged the activity of the existing volcanoes settled in ocean centres, or along coast-lines, while the great inland volcanic areas of Auvergne, the Eifel, Central Asia, etc., have become dormant or extinct.

But if water only plays a secondary part in volcanic eruptions, to what is the motive power which causes the extravasation of the lava to be attributed? This involves questions connected with the solidity of the globe far more hypothetical and difficult of proof. The author first takes into consideration the probable thickness of the earth's crust from a geological point of view, and show, that although the present stability of the earth's surface renders it evident that the hypothesis of a thin crust resting on a fluid nucleus is untenable, it is equally difficult to reconcile certain geological phenomena with a globe solid throughout, or even with a very thick crust. The geological phenomena on which he relies in proof of a crust of small thickness are: (1) Its flexibility as exhibited down to the most recent mountain uplifts, and in the elevation of continental areas. (2) The increase of temperature with depth. (3) The volcanic phenomena of the present day, and the outwelling of the vast sheets of trappean rocks during late geological periods.

He considers that the squeezing and doubling up of the strata in mountain-chains—as, for example, the 200 miles of originally horizontal strata in the Alps, crushed into a space of 130 miles (and in some cases the compression is still greater)—can only be accounted for on the assumption of a thin crust resting on a yielding substratum, for the strata have bent as only a free surface-plate could to the deformation caused by lateral pressure. If the globe were solid, or the crust of great thickness, there would have been *crushing* and *fracture*, but not *corrugations*. Looking at the dimensions of these folds, it is evident also that the plate could not be of any great thickness. This in connection with the increase of heat with depth, and the rise of the molten lava through volcanic ducts, which, if too long, would allow the lava to consolidate, leads the author to believe that the outer solid crust may be less even than twenty miles thick.

That the crust does possess great mobility is shown by the fact that since the glacial period there have been movements of continental upheaval—to at least the extent of 1,500 to 1,800 feet; that within more recent times they have extended to the height of 300 to 400 feet or more, and they have not yet entirely ceased.

With regard to the suggestion of the late Prof. Hopkins that the lava lies in molten lakes at various depths beneath the surface, the author finds it difficult to conceive their isolation as separate and independent local igneous centers, in presence of the large areas occupied by modern and by recently extinct volcanoes. But the chief objection is that if such lakes existed, they would tend to depletion, and as they could not be replenished from surrounding areas, the surface above would cave in and become depressed, whereas areas of volcanic activity are usually areas of elevation, and the great basaltic outwellings of Colorado and Utah, instead of being accompanied by depression, form tracts raised 5,000 to 12,000 feet above the sea-level.

These slow secular upheavals and depressions, this domed elevation of great volcanic areas, the author thinks most compatible with the movement of a thin crust on a slowly yielding viscid body or layer, also of no great thickness, and wrapping round a solid nucleus. The viscid magma is thus compressed between the two solids, and while yielding in places to compression, it, as a consequence of its narrow limits, expands in like proportion in conterminous areas. As an example, he instances the imposing slow movements of elevation which have so long been going on along almost all the land bordering the shores of the polar seas, and to the areas of depression which so often further south subtend the upheaved districts.

With respect to the primary cause of these changes and of the extravasation of lava, the author sees no hypothesis which meets all the conditions of the case so well as the old hypothesis of secular refrigeration and contraction of a heated globe, with a solid crust—not as originally held, with a fluid nucleus, but with the modifications which he has named, and with a *quasi rigidity* compatible with the conclusions of the eminent physicists who have investigated this part of the problem. Although the loss of terrestrial heat by radiation is now exceedingly small, so also is the contraction needed for the quantity of lava ejected. Cor-

* From a paper read before the Royal Society, April 16, 1885.

dier long since calculated that, supposing five volcanic eruptions to take place annually, it would require a century to shorten the radius of the earth to the extent of 1 mm., or about $\frac{1}{25}$ inch.

The author therefore concludes that, while the extravasation of the lava is due to the latter cause, the presence of vapor is due alone to the surface and underground waters with which it comes into contact as it rises through the volcanic duct, the violence of the eruption being in exact proportion to the quantity which so gains access.

THE PAPAW.

To those accustomed only to see small plants in hothouses, our illustration, showing the size to which the plant attains in Mexico, may come as a surprise. The papaws are permeated by a milky juice, which has the singular property of rendering tough meat tender; in fact, the active principle, papain, has been proved to have a soluble effect on albumen and fibrin, and hence the explanation of its peculiar properties.

Papain has even been used successfully to soften and loosen the membranous outgrowth from the skin of the throat which is attended with such fatal results in cases of diphtheria. Fig leaves, according to M. Van Volxem, have similar properties.

In our stoves the papaws are handsome shrubs or trees, with bold palmately-lobed leaves, and clusters of small cream-colored, bell-shaped flowers, containing, some stamens, others pistils. Sometimes the sexes are on different trees, sometimes on the same, and we have more than once met with flowers which bore stamens and pistils within the same flower. The matter is of some importance because, of course, if a purely male plant be cultivated no fruit is obtained, and the fruit, though of little value as an article of diet in this country, is ornamental and striking in appearance. In the tropics it is used in a cooked condition, in curries, pickles, etc. There are several species; the best known is C. papaya; C. cundinamarcensis, so-called from Cundinamarca, a State in New Granada, is of smaller stature; C. erythrocarpa has crimson fruit. M. Van Volxem has raised various hybrids interesting for the beauty of their fruits, and of some of which we have given illustrations on a former occasion.—*The Gardeners' Chronicle.*

PAPAW TREE—CARICA PAPAYA.

WHEN coal-gas flows through a pipe and burns in the air, and one end of the pipe (say three feet) can be disconnected in a moment, the flame continues to burn, the air flowing in beneath. The flame burns a shorter time when the tube has a vertical position. When two of such tubes are disconnected mechanically at the same moment, a very small section can be measured by ascertaining the difference of the time of burning of the flames on the two tubes supposed to be of the same length and position to the vertical line. In this way I have demonstrated before a large audience that a chimney in which two matches are burned is a stronger exhauster than the same chimney in which only one is burned. In the same manner I have proved that a chimney with short turns draws less with the same quantity of fuel than a straight one of the same dimensions.—*L. C. Levoir, Chem News.*

SUNLIGHT AND THE EARTH'S ATMOSPHERE.*

THERE is, we may remember, a passage in which Plato inquires what would be the thoughts of a man who, having lived from infancy under the roof of a cavern, where the light outside was inferred only by its shadows, was brought for the first time into the full splendors of the sun. We may have enjoyed the metaphor without thinking that it has any physical application to ourselves, who appear to have no roof over our heads, and to see the sun's face daily; while the fact is, that if we do not see that we have a roof over our heads in our atmosphere, and do not think of it as one, it is because it seems so transparent and colorless.

Now, I wish to ask your attention to-night to considerations in some degree novel, which appear to me to show that it is not transparent, as it appears, and that this seeming colorlessness is a sort of delusion of our senses, owing to which we have never in all our lives seen the true color of the sun, which is in reality blue rather than white, as it looks; so that this air all about and above us is acting like a colored glass roof over our heads, or a sort of optical sieve, holding back the excess of blue in the original sunlight, and letting only the white sift down to us. I will first ask you, then, to consider that this seeming colorlessness of the air may be a delusion of our senses, due to habit, which has never given us anything else to compare it with.

If that cave had been lit by sunshine coming through a reddish glass in its roof, would the perpetual dweller in it ever have had an idea but that the sun was red? How is he to know that the glass is "colored," if he has never anything in his life to compare it with? How can he have any idea but that this is the sum of all the sun's radiations (corresponding to our idea of white or colorless light)? Will not the habit of his life confirm him in the idea that the sun is red? and will he not think that there is no color in the glass, so long as he cannot go outside to see? Has this any suggestion for us, who have none of us ever been outside our crystal roof to see? We must all acknowledge in the abstract, that habit is equally strong in us, whether we dwell in a cave or under the sky; that what we have thought from infancy will probably appear the sole possible explanation; and that, if we want to break its chain, we should put ourselves, at least in imagination, under conditions where it no longer binds us.

The Challenger has dredged from the bottom of the ocean fishes which live habitually at great depths, and whose enormous eyes tell of the correspondingly faint light which must have descended to them through the seemingly transparent water. It will not be so futile a speculation as it may at first seem, to put ourselves in imagination in the condition of creatures under the sea, and ask what the sun may appear to them; for, if the fish who had never risen above the ocean floor were an intelligent being, might *he* not plausibly reason that the dim greenish light of his heaven—which is all he has ever known—was the full splendor of the sun, shining through a medium which all his experience shows is transparent? We ourselves are, in very fact, living at the floor of a great aerial sea, whose billows roll hundreds of miles above our heads. Is it not, at any rate, conceivable that we may have been led into a like fallacy from judging only by what we see at the bottom? May we not, that is, have been led into the fallacy of assuming that the intervening medium above us is colorless because the light which comes through it is so?

I freely admit that all men, educated or ignorant, appear to have the evidence of their senses that the air is colorless, and that pure sunlight is white; so that, if I venture to ask you to listen to considerations which have lately been brought forward to show that it is the sun which is blue, and the air really acts like an orange veil, or like a sieve which picks out the blue and leaves the white, I do so in the confidence that I may appeal to you on other grounds than those I could submit to; the primitive man, who has his senses alone to trust to for the educated intelligence possesses those senses equally, and, in addition, the ability to interpret them by the light of reason; and before this audience it is to that interpretation that I address myself.

Permit me a material illustration. You see through this glass, which may typify the intervening medium of air or water, a circle of white light, which may represent the enfeebled disk of the sun when so viewed. Is this intervening glass colored, or not? It seems nearly colorless; but have we any right to conclude that it is so because it seems so? Are we not *taking it for granted* that the original light which we see through it is white, and that the glass is colorless because the light seems unaltered? and is not an appeal to be made here from sense to reason, which, in the educated observer, recalls that white light is made of various colors, and that whether the original light is really white and the glass transparent, or the glass really colored and so *making* the white, is to be decided only by experiment, by taking away the possibly deceptive medium? I can take away this glass which was not colorless, but of a deep orange, and you see that the original light was not white, but intensely blue. If we could take the atmosphere away between us and the sun, how can we say that the same result might not follow? To make the meaning of our illustration clearer, observe that this blueness is not a pure spectral blue. It has in it red, yellow, blue, and all colors which make up white, but blue in superabundance; so that, though the white is, so to say, latent there, the dominant effect is blue. The glass colored veil does not put anything in, but acts, I repeat, like a sieve straining *out* the blue, and letting through to us the white light which was there in the bluishness; and so may not our air do so too?

I think we already begin to see that it is at any rate, conceivable that we may have been hitherto under a delusion about the true color of the sun, though of course this is not proving that we have been so. And it will at any rate, I hope, be evident that here is a question raised which ought to be settled; for the blueness of the sun, if proven, evidently affects our present knowledge in many ways, and will modify our present views in optics, in meteorology, and in numerous other things, in optics, because we should find that white light is *not* the sum of the sun's radiations, but only of those dregs of them which have filtered down to us; in meteorology, because it is suggested that the temperature of the globe, and the condition of man on it, depend in part on a curious selective action of our air, which picks out parts of the solar heat (for instance, that connected with its blue light), and holds them back, letting other selected portions come to us, and so altering the conditions on which this heat by which we live depends; in other ways innumerable, because, as we know, the sun's heat and light are facts of such central importance, that they affect almost every part of scientific knowledge.

It may be asked, What suggested the idea that the sun may be blue rather than any other color? My own attention was first directed this way many years ago, when measuring the heat and light from different parts of the sun's disk. It is known that the sun has an atmosphere of its own, which tempers its heat, and by cutting of certain radiations, and not others, produces the spectral lines we are all familiar with. These lines we customarily study in connection with the absorbing vapors of sodium, iron, and so forth, which produce them: but my own attention was particularly given to the regions of absorption, or to the color it caused; and I found that the sun's body must be deeply bluish, and that it would shed blue light, except for this apparently colorless solar atmosphere which really plays the part of a reddish veil, letting a little of the blue appear on the center of the sun's disk where it is thinnest, and staining the edge red, so that to delicate tests the center of the sun is a pale aquamarine, and its edge a garnet. The effect I found to be so important, that, if this all but invisible solar atmosphere were diminished by but a third part, the temperature of the British Islands would rise above that of the torrid zone; and this directed my attention to the great practical importance of studying the action of our own terrestrial atmosphere on the sun, and the antecedent probabilty that our own air was also and independently making the really blue sun into an apparently white one. We actually know, then, beyond conjecture, by a comparison of the sun's atmosphere where it is thickest, and where it is thinnest, that an apparently colorless atmosphere can have such an effect; and analogous observations which I have carried on for many years, but do not now detail, show that the atmosphere of our own planet, this seemingly clear air in which we exist like creatures at the bottom of the sea, does do so. We look up through our own air as through something so limpid in its purity, that it appears scarcely matter at all; and we are apt to forget the enormous mass of what seems of such lightness, but which really presses with nearly a ton to each square foot, so that the weight of all the buildings in this great city, for instance, is less than that of the air above them.

I hope shortly to describe the method of proof that it, too, has been acting like an optical sieve, holding back the blue; but it may naturally be asked, Can our senses have so entirely deceived us that they give no hint of this truth, if it be one? Is the appeal wholly to recondite scientific methods, and are there no indications, at least, which we may gather for ourselves? I think there are, even to our unaided eyes, indications that the seemingly transparent air really acts as an orange medium, and keeps the blue light back in the upper sky.

* A lecture delivered at the Royal Institution, April 17, 1885, by Prof. S. P. Langley, of Alleghany.

If I hold this piece of glass before my eyes, it seems colorless and transparent; but it is proved not to be so by looking through it edgewise, when the light, by traversing a greater extent, brings out its true color, which is yellow. Every one knows this in every day experience. We shall not get the color of the ocean by looking at it in a wine glass, but by gazing through a great depth of it, and so it is with the air. If we look directly up, we look through where it is thinnest; but if we look horizontally through it toward the horizon, through great thicknesses, as at sunrise or sunset, is it not true that this air, where we see its real color most plainly, makes the sun look very plainly yellow or orange? We not only see here, in humid English skies, the orange sunset waning slow, but most of us, in these days of travel, can perfectly testify that the clearest heavens the earth affords, the rosy tint on the snows of Mont Blanc, forerunning the dawn, or the warm glow of the sun as he sets in Egyptian skies, show this most clearly—show that the atmosphere holds back the blue rays by preference, and lets the orange through.

If next we ask, What has become of the blue that it has stopped? does not the very blue of the mid-day sky relate the rest of the story, that blue which Prof. Tyndall has told us is due to the presence of innumerable fine particles in the air, which act selectively on the solar waves, diffusing the blue light toward us? I hope it will be understood that Professor Tyndall is in no way responsible for my own inferences; but I think it is safe, at least, to say that the sky is not self-luminous, and that, since it can only be shining blue at the expense of the sun, all the light this sky sends us has been taken by our atmosphere away from the direct solar beam, which would grow both brighter and bluer if this were restored to it.

If all that has been said so far renders it possible that the sun may be blue, you will still have a right to say that "possibilities" and "maybees" are not evidence, and that no chain of mere hypotheses will draw Truth out of her well. We are all of one mind here, and I desire next to call your attentien to what I think is evidence.

Remembering that the case of our supposed dweller in the cave who could not get outside, or that of the inhabitants of the ocean floor who cannot rise to the surface, is really like our own, over whose heads is a crystalline roof which no man from the beginning of time has ever got outside of—an upper sea to whose surface we have never risen—we recognize that if we could rise to the surface, leaving the medium whose effect is in dispute wholly beneath us, we should see the sun as it is, and get proof of an incontrovertible kind; and that, if we can not entirely do this, we shall get nearest to proof under our real circumstances by going as high as we can in a balloon, or by ascending a very high mountain. The balloon will not do, because we have to use heavy apparatus requiring a solid foundation. The proof to which I ask your kind attention, then, is that derived from the actual agcent of a remarkable mountain by an expedition undertaken for that purpose, which carried a whole physical laboratory up to a point where nearly one-half the whole atmosphere lay below us. I wish to describe the difference we found in the sun's energy at the bottom of the mountain, and at the top, and then the means we took to allow forthe effect of that part of the earth's atmosphere still over our heads even here, so that we may be said to have virtually got outside it altogether.

Before we begin our ascent, let me explain more clearly what we are going to seek. We need not expect to find that the original sunlight is a pure mono-chromatic blue by any means, but that though its rays contain red, orange, blue, and all the other spectral colors, the blue, the violet, and the allied tints were originally there in disproportionate amounts; so that, though all which make white were present from the first, the refrangible end of the spectrum had such an excess of color, that the dominant effect was that of a bluish sun. In the same way, when I say briefly, that our atmosphere has absorbed this excess of blue and let the white reach us, I mean, more strictly speaking, that this atmosphere has absorbed *all* the colors, but selectively taking out more orange than red, more green than orange, more blue than green; so that its action is wholly a taking *out*, an action like that which you now see going on with this sieve, sifting a mixture of blue and white beads, and holding back the blue, while letting the white fall down.

This experiment only rudely typifies the action of the atmosphere, which is discriminating and selective in an amazing degree; and, as there are really an infinite number of shades of color in the spectrum, it would take forever to describe the action in detail. It is merely for brevity, then, that we now unite the more refrangible colors under the general word "blue," and the others under the corresponding terms "orange" or "red."

All that I have the honor to lay before you is less an announcement of absolute novelty than an appeal to your already acquired knowledge, and to your reason as superior to the delusions of sense. I have, then, no novel experiment to offer, but to ask you to look at some familiar ones in a new light. We are most of us familiar, for instance, with that devised by Sir Isaac Newton to show that white light is compounded of blue, red, and other colors, where, by turning a colored wheel rapidly, all blend into a grayish white. Here you see the "seven colors" on the screen; but, though all are here, I have intentionally arranged them so that there is too much blue, and the combined result is a very bluish white, which may roughly stand for that of the original sun ray. I now alter the proportion of colors so as to virtually take out the excess of blue, and the result is colorless or white light. White, then, is not necessarily made by combining the "seven colors," or any number of them, unless they are there in just proportion (which is in effect what Newton himself says); and white, then, may be made out of such a bluish light as we have described, not by putting anything to it, but by taking away the excess which is there already.

Here, again, are two sectors—one blue, one orange-yellow with the blue in excess—making a bluish disk where they are revolved. I take out the excess of blue, and now what remains is white. Here is the spectrum itself on the screen, but a spectrum which has been artificially modified so that the blue end is relatively too strong. I recombine the colors (by Prof. Rood's ingenious device of an elastic mirror), and they do not make a pure white, but one tinted with blue. I take out the original excess of blue, and what remains combines into a pure white. Please bear in mind that when we "put in" blue here, we have to do so by straining out other light through some obscuring medium, which makes the spectrum darker, but that, in the case of the actual sunlight, introducing more blue introduces more light, and makes the spectrum brighter.

The spectrum on the screen ought to be made still brighter in the blue than it is—far, far brighter—and then it might represent to us the original solar spectrum before it has suffered any absorption either in the sun's atmosphere or our own. The Fraunhofer lines do not appear in it; for these, when found in the solar spectrum, show that certain individual rays have been stopped, or selected for absorption by the intervening atmospheres; and, though even the few yards of atmosphere between the lamp and the screen absorb, is not enough to show.

Our spectrum, as it appears before absorption, might be compared to an army divided into numerous brigades, each wearing a distinct uniform, one red, one green, one blue; so that all the colors are represented each by its own body. If, to represent the light absorbed as it progresses, we supposed that the army advances under a fire which thins its numbers, we should have to consider that (to give the case of nature) this destructive fire was directed chiefly against those divisions which were dressed in blue, or allied colors, so that the army was thinned out unequally, many men in blue being killed off for one in red; and that, by the time it has advanced a certain distance under fire, the proportion of the men in each brigade has been altered, the red being comparatively unhurt. Almost all absorption is thus selective in its action, and often in an astonishing degree; killing off, so to speak, certain rays in preference to others, as though by an intelligent choice, and not only destroying most of certain divisions (to continue our illustration), but even picking out certain files in each company. Every ray, then, has its own individuality, and on this I cannot too strongly insist; for just as two men retain their personalities under the same red uniform, and one may fall and the other survive, though they touch shoulders in the ranks, so in the spectrum certain parts will be blotted out by absorption, while others next to them may escape.

To illustrate this effective absorption, I put a piece of didymium glass in the path of the ray. It will, of of course, absorb some of the light; but, instead of dimming the whole spectrum, we might almost say it has arbitrarily chosen to select one narrow part for action, in this particular case choosing a narrow file near the orange, and letting all the rest go unharmed. In this arbitrary way our atmosphere operates, but in a far more complex manner, taking out a narrow file here, and another there, in hundreds of places all through the spectrum, but, on the whole, much the most in the blue, the Fraunhofer lines being merely part of the evidence of this wonderful quasi-intelligent action which bears the name of selective absorption.

Before we leave this spectrum, let us recall one most important matter We know that here, beyond the red, is solar energy in the form of heat, which we cannot see, but not on that account any less important. More than half the whole power of the sun is here invisible, and, if we are to study completely the action of our atmosphere, we shall have to pay great attention to this part, and find out some way of determining the loss in it; which will be difficult, for the ultra-red end is not only invisible, but compressed, the red end being shut up like the closed pages of a book, as you may notice by comparing the narrowness of the red with the width of the blue.

Now, refraction by a prism is not the only way of forming a spectrum. Nature furnishes us color not only from the rainbow, but from non-transparent substances, like mother of pearl, where the iridescent hues are due to microscopically fine lines. Art has lately surpassed nature in these wonderful "gratings," consisting of pieces of polished metal, in which we see at first nothing to account for the splendid play of color apparently pouring out from them like light from an opal, but which, on examination with a powerful microscope, show lines so narrow that there are from fifty to a hundred in the thickness of a fine human hair, and all spaced with wonderful precision.

This grating is equal in defining power to many such prisms as we have just been looking at, but its light does not show well upon the screen. You will see, however, that its spectrum differs from that of the prism, in that in this case the red end is expanded, as compared with the violet, and the invisible ultra-red is expanded still more; so that this will be the best means for us to use in exploring that "dark continent" of invisible heat found in the spectrum of not only the sun, but of the electric light, and of all incandescent bodies, and of whose existence we already know from Herschel and Tyndall.

Now, we cannot reproduce the actual solar spectrum on the screen, without the sun itself; but here are photographs of it, which show parts of the losses the different colors have suffered on their way to us. We have before us the well known Fraunhofer lines, due, you remember, not only to absorption in the sun's atmosphere, but also to absorption in our own. We have been used to think of them in connection with their cause, one being due to the absorption of iron vapor in the sun, another to that of water vapor in our own air, and so forth; but now I ask you to think of them only in connection with the fact that each is due to the absorption of some part of the original *light*, and that collectively they tell much of the story of what has happened to that light on its way down to us. Observe, for instance, how much thicker they lie in the blue end than in the red, another evidence of the great proportionate loss in the blue.

If we could restore all the lost light in these lines, we should get back partly to the original condition of things at the very fount; and, so far as our own air is concerned, that is what we are to ascend the mountain for—to see, by going up through nearly half of the atmosphere, what the rate of loss is in each ray by actual trial; then, knowing this rate, to be able to allow for the loss in the other part still above the mountain-top; and, finally, by recombining these rays, to get the loss as a whole. Remember, however, always, that the most important part of the solar energy is in the dark spectrum, which we do not see, but which, if we could see, we should probably find to have numerous absorption spaces in it corresponding to the Fraunhofer lines, but where heat has been stopped out rather than light. To make our research thorough, then, we ought not to trust to the eye only, or even chiefly, but have some way of investigating the whole spectrum—the invisible, in which the sun's power chiefly lies, as well as the visible, and both with an instrument that would discriminate the energy in these very narrow spaces like an eye to see in the dark; and, if science possesses no such instrument, then it may be necessary to invent one.

The linear thermopile is nearest to it of any, and we all here know what good work it has done; but even that is not sensitive enough to measure in the grating spectrum, in some parts of which the heat is four hundred times weaker than in that of a prism, and we want to observe this invisible heat in very narrow spaces. Something like this has been provided since by Captain Abney's most valuable researches; but these did not at the time go low enough for my purpose, and I spent nearly a year, before ascending the mountain, in inventing and perfecting the new instrument for measuring these, which I have called the "bolometer," or "ray-measurer." The principle on which it is founded is the same as that employed by my late lamented friend, Sir William Siemens, for measuring temperatures at the bottom of the sea, which is, that a smaller electric current flows through a warm wire than through a cold one.

One great difficulty, was to make the conducting-wire very thin, and yet continuous; and for this purpose, almost endless experiments were made; among other substances, pure gold having been obtained by chemical means in a plate so thin that it transmitted a sea-green light through the solid substance of the metal. This proving unsuitable, I learned that iron had been rolled of extraordinary thinness in a contest of skill between some English and American iron-masters; and, procuring some, I found that fifteen thousand of the iron plates they had rolled, laid one on the other, would make but one English inch. Here is some of it, rolled between the same rolls which turn out plates for an iron-clad, but so thin, that, as I let it drop, the iron plate flutters down like a dead leaf. Out of this the first bolometers were made; and I may mentioned that the cost of these earlier experiments was met from a legacy by a founder of the Royal Institution, Count Rumford. The iron is now replaced by platinum, in wires, or rather tapes, from a two-thousandth to a twenty-thousandth of an inch thick, one of which is within this button, where it is all but invisible, being far finer than a human hair. I will project it on the screen, placing a common small pin beside it as a standard of comparison. This button is placed in this ebonite case, and the thread is moved by this micrometer screw, by which it can be set like the spider-line of a reticule; but by means of this cable, connecting it to the galvanometer, this thread acts as though sensitive, like a nerve laid bare to every indication of heat and cold. It is, then, a sort of sentient thing; what the eye sees as light it feels as heat, and what the eye sees as a narrow band of darkness (the Fraunhofer line) this feels as a narrow belt of cold; so that, when moved parallel to itself and the Fraunhofer lines down the spectrum, it registers their presence.

It is true, we can see these in the visible spectrum. But you remember, we propose to explore the invisible also; and, since to this dark is the same as the light, it will feel absorption-lines in the infra-red which might remain otherwise unknown.

I have spent a long time in these preliminary researches, in indirect methods for determining the absorption of our atmosphere, and in experiments and calculations which I do not detail; but it is so often supposed that scientific investigation is a sort of happy guessing, and so little is realized of the labor of preparation and proof, that I have been somewhat particular in describing the essential parts of the apparatus finally employed; and now we must pass to the scene of their use.

We have been compared to creatures living at the bottom of the sea, who frame their deceptive traditional notions of what the sun is like from the feeble, changed rays which sift down to them. Though such creatures could not rise to the surface, they might swim up toward it; and if these rays grew hotter, brighter, and bluer, as they ascended, it would be almost within the capacity of a fish's mind to guess that they are still brighter and bluer at the top. Since we children of the earth, while dwelling on it, are always at the bottom of a sea, though of another sort, the most direct method of proof I spoke of, is merely to group as far as we can, and observe what happens; though, as we are men, and not fishes, something more may fairly be expected of our intelligence than of theirs.

We will not only guess, but measure and reason; and in particular we will first, while still at the bottom of the mountain, draw the light and heat out into a spectrum, and analyze every part of it by some method that will enable us to explore the invisible, as well as record the visible. Then we will ascend many miles into the air, meeting the rays on the way down, before the sifting process has done its whole work, and there analyze the light all over again, so as to be able to learn the different proportions in which the different rays have been absorbed, and, by studying the action on each separate ray, to prove the state of things which must have existed before this sifting—this selective absorption—began.

It may seem at first that we cannot ascend far enough to do much good, since the surface of our aerial ocean is hundreds of miles overhead; but we must remember that the air grows thinner as we ascend, the lower atmosphere being so much denser that about one-half the whole substance or mass of it lies within the first four miles, which is a less height than the tops of some mountains. Every high mountain, however, will not do; for ours must not only be very high, but very steep; so that the station we choose at the bottom may be almost under the station we are afterward to occupy at the top. Besides, we are not going to climb a lofty, lonely, summit, like tourists, to spend an hour, but to spend weeks; so that we must have fire and shelter, and, above all, we must have dry air to get clear skies. First I thought of the Peak of Teneriffe; but afterward some point in the territories of the United States seemed preferable, particularly as the government offered to give the expedition, through the signal-service, and under the direction of its head, Gen. Hazen, material

help in transportation, and a military escort, if needed, anywhere in its own dominions. No summit in the eastern part of the United States rises much over seven thousand feet, and, though the great Rocky Mountains reach double this, their tops are the home of fog and mist; so that the desired conditions, if met at all, could only be found on the other side of the continent, in southern California, where the summits of the Sierra Nevada rise precipitously out of the dry air of the great wastes in lonely peaks, which look eastward down from a height of nearly fifteen thousand feet upon the desert lands.

This remote region was, at the time I speak of, almost unexplored; and its highest peak, Mount Whitney, had been but once or twice ascended, but was represented to be all we desired, could we once climb it. As there was great doubt whether our apparatus, weighing several thousand pounds, could possibly be taken to the top, and we had to travel three thousand miles even to get where the chief difficulties would begin, and make a desert journey of a hundred and fifty miles after leaving the cars, it may be asked why we committed ourselves to such an immense journey, to face such unknown risks of failure. The answer must be, that mountains of easy ascent, and fifteen thousand feet high, are not to be found at our doors, and that these risks were involved in the nature of our novel experiment; so that we started out from no love of mere adventure, but from necessity, much into the unknown. The liberality of a citizen of Pittsburg, to whose encouragement the enterprise was due, had furnished the costly and delicate apparatus for the expedition; and that of the transcontinental railroads enabled us to take this precious freight along in a private car, which carried a kitchen, a steward, a cook, and an ample larder besides.

In this we crossed the entire continent from ocean to ocean, stopped at San Francisco for the military escort, went three hundred miles south so as to get below the mountains, and then turned eastward again on to the desert, with the Sierras to the north of us, after a journey which would have been unalloyed pleasure except for the anticipation of what was coming as soon as we left our car. I do not, indeed, know that one feels the triumphs of civilization over the opposing forces of nature anywhere more than in the sharp contrasts which the marvelous luxury of recent railroad accommodation gives to the life of the desert. When one is in the center of one of the great barren regions of the globe, and, after looking out from the windows of the flying train on its scorched wastes for lonely leagues of habitless desolation, turns to his well-furnished dinner-table, and the fruit and ices of his dessert, he need not envy the heroes of oriental story who were carried across dreadful solitudes in a single night on the backs of flying genii. Ours brought us over three thousand miles to the Mojave desert. It was growing hotter and hotter when the train stopped in the midst of vast sand-wastes a little after midnight. Roused from our sleep, we stepped on to the brown sand, and saw our luxurious car roll away in the distance, experiencing a transition from the conditions of civilization to those almost of barbarism, as sharp as could well be imagined. We commenced our slow toil northward with a thermometer at 110° in the shade, if any shade there be in the shadeless desert, which seem to be chiefly inhabited by rattlesnakes of an ashen gray color and a peculiarly venomous bite. There is no water save at the rarest intervals, and the soil at a distance seems as though strewed with sheets of salt, which aids the delusive show of the mirage. These are, in fact, the ancient beds of dried-up salt lakes or dead seas, some of them being below the level of the ocean; and such a one on our right, though only about twenty miles wide, has earned the name of "Death Valley," from the number of human beings who have perished in it. Formerly an emigrant train, when emigrants crossed the continent in caravans, had passed through the great Arizona deserts in safety, until, after their half-year's journey, their eyes were gladdened by the snowy peaks of the Sierras looking delusively near. The goal of their long toil seemed before them; only this one more valley lay between; and into this they descended, thinking to cross it in a day, but they never crossed it. Afterward the long line of wagons was found, with the skeletons of the animals in the harness, and by them those of men, women, and little children, dead of thirst; and some relics of the tragedy remained at the time of our journey. I cite this as an indirect evidence of the phenomenal dryness of the region—a dryness which so far served our object, which was, in part, to get rid, as much as possible, of that water-vapor which is so well known to be a powerful absorber of the solar heat.

Everything has an end; and so had that journey, which finally brought us to the goal of our long travel at the foot of the highest peak of the Sierras, Mount Whitney, which rose above us in tremendous precipices that looked hopelessly insurmountable and wonderfully near. The whole savage mountain region, in its slow rises from the west, and its descent to the desert plains in the east, is more like the chain called the Apennines, in the moon, than anything I know on the earth. The summits are jagged peaks, like Alpine "needles," looking in the thin air so delusively near, that, coming on such a scene unprepared, one would almost say they were large gray stones a few fields off, with an occasional little white patch on the top that might be a handkerchief or a sheet of paper dropped there. But the telescope showed that the seeming stones were of the height of many Snowdons piled on one another, and the white patches occasional snow-fields, looking now invitingly cool from the torrid heat of the desert, where we were encamped by a little rivulet that ran down from some unseen ice-lake in that upper air. Here we pitched our tents, and fell to work (for you remember we must have two stations, a low and a high one, to compare the results); and here we labored three weeks in almost intolerable heat, the instruments having to be constantly swept clear of the red desert dust which the hot wind brought. Close by these tents, a thermometer covered by a single sheet of glass, and surrounded by wool, rose to 237° in the sun; and sometimes in the tent, which was darkened for the study of separate rays, the heat was absolutely beyond human endurance. Finally, our apparatus was taken apart, and packed in small pieces on the backs of mules, who were to carry it by a ten-days' journey through the mountains to the other side of the rocky wall, which, though only ten or twelve miles distant, arose miles above our heads; and, leaving these mule-trains to go with the escort by this longer route, I started with a guide by a nearer way to those white gleams in the upper skies that had daily tantalized us below in the desert with suggestions of delicious, unattainable cold. That desert sun had tanned our faces to a leather-like brown, and the change to the cooler air as we ascended was at first delightful. At an altitude of five thousand feet we came to a wretched band of nearly naked savages, crouched around their camp-fire, and at six thousand found the first scattered trees; and here the feeble suggestion of a path stopped, and we descended a ravine to the bed of a mountain stream, up which we forced our way, cutting through the fallen trees with an axe, fighting for every foot of advance, and finally passing what seemed impassable. It was interesting to speculate as to the fate of our siderostat mirrors and other precious freight, now somewhere on a similar road, but quite useless. We were committed now, and had to make the best of it; and, besides, I had begun to have my attention directed to a more personal subject. This was, that the colder it grew, the more the sun burnt the skin—quite literally burnt, I may say; so that by the end of the third day my face and hands, case-hardened, as I thought, in the desert, began to look as if they had been seared with red-hot irons, here in the cold, where the thermometer had fallen to freezing at night; and still, as we ascended, the paradoxical effect increased. The colder it grew about us, the hotter the sun blazed above. We have all heard, probably, of this curious effect of burning in the midst of cold, and some of us may have experienced it in the Alps, where it may be aided by reflection from the snow, which we did not have about us at any time except in scattered patches; but here by the end of the fourth day, my face was scarcely recognizable, and it almost seemed as though sunbeams up here were different things, and contained something which the air filters out before they reach us in our customary abodes. Radiation here is increased by the absence of water-vapor, too; and, on the whole, this intimate personal experience fell in almost too well with our anticipations that the air is an even more elaborate trap to catch the sunbeams than had been surmised, and that this effect of selective absorption and radiation was intimately connected with that change of the primal energies and primal color of the sun which we had climbed towards it to study.

On the fourth day, after break-neck ascents and descents, we finally ascended by a ravine down which leaped a cataract, till, at nightfall, we reached our upper camp, which was pitched by a little lake, one of the sources of the waterfall, at a height of about twelve thousand feet, but where we seemed in the bottom of a valley, nearly surrounded as we were by an amphitheater of rocky walls which rose perpendicularly to the height of Gibraltar from the sea, and cut off all view of the desert below, or even of the peak above us. The air was wonderfully clear; so that the sun set in a yellow rather than an orange sky, which was reflected in the little ice-rimmed lakes, and from occasional snow-fields on the distant waste of lonely mountain summits on the west.

The mule-train, sent off before by another route, had not arrived when we got to the mountain camp, and we realized that we were far from the appliances of civilization by our inability to learn about our chief apparatus; for here, without post or telegraph, we were as completely cut off from all knowledge of what might be going on with it in the next mountain ravine as a ship at sea is of the fate of a vessel that sailed before from the same port. During the enforced idleness, we ascended the peak nearly three thousand feet above us, with our lighter apparatus, leaving the question of the ultimate use of the heavy ones to be settled later. There seemed little prospect of carrying it up, as we climbed where the granite walls had been split by the earthquakes, letting a stream of great rocks, like a stone river, flow down through the interstices by which we ascended; and, in fact, the heavier apparatus was not carried above the mountain camp.

The view from the very summit was over numberless peaks on the west to a horizon, fifty miles away, of unknown mountain-tops; for, with the exception of the vast ridge of Mount Tyndall, and one or two less conspicuous ones, these summits are not known to fame; and wonderful as the view may be, all the charm of association with human interest which we find in the mountain landscape of older lands is here lacking. It was impossible not to be impressed with the savage solitude of this desert of the upper air, and our remoteness from man and his works; but I turned to the study of the special things connected with my mission. Down far below, the air seemed filled with reddish dust that looked like an ocean. This dust is really present everywhere (I have found it in the clear air of Etna); and though we do not realize its presence in looking up through it, to one who looks down on it, the dwellers on the earth seem indeed like creatures at the bottom of a troubled ocean. We had certainly risen toward the surface; for about us the air was of exquisite purity, and above us the sky was of such a deep violet-blue as I have never seen in Egypt or Sicily; and yet even this was not absolutely pure, for, separately invisible, the existence of fine particles could yet be inferred from their action on the light near the sun's edge; so that even here we had not got absolutely above that dust-shell which seems to encircle our whole planet. But we certainly felt ourselves not only in an upper, but a different region. We were on the ridge of the continent; and the winds which tore by had little in common with the air below, and were bearing past us (according to the geologists) dust which had once formed part of the soil of China, and been carried across the Pacific Ocean; for here we were lifted into the great encircling currents of the globe, and, "near to the sun in lonely lands," were in the right conditions to study the differences between his rays at the surface, and at the bottom of that turbid sea where we had left the rest of mankind. We descended the peak, and hailed with joy the first arrival of our mule-trains with the requisite apparatus at the mountain camp, and found that it had suffered less than might be expected, considering the pathless character of the wilderness. We went to work to build piers, and mount telescopes and siderostats, in the scene shown by the next illustration on the screen, taken from a sketch of my own, where these rocks in the immediate foreground rise to thrice the height of St. Paul's. We suffered from cold (the ice forming three inches deep in the tents at night) and from mountain sickness; but we were too busy to pay much attention to bodily comfort, and worked with desperate energy to utilize the remaining autumn days, which were all too short.

Here, as below, the sunlight entered a darkened tent, and was spread into a spectrum, which was explored throughout by the bolometer, measuring on the same separate rays which we had studied below in the desert, all of which were different up here, all having grown stronger, but in very different proportions. On the screen is the spectrum as seen in the desert, drawn on a conventional scale, neither prismatic nor normal, but such that the intensity of the energy shall be the same in each part, as it is represented here by these equal perpendiculars in every color. Fix your attention on these three as types, and you will see better what we found on the mountain, and what we inferred as to the state of things still higher up, at the surface of the aerial sea.

You will obtain, perhaps, a clearer idea, however, from the following statement, where I use, not the exact figures used in calculation, but round numbers, to illustrate the process employed. I may premise that the visible spectrum extends from H (in the extreme blue) to A (in the deepest red), or from near 40 (the ray of forty hundred-thousandths of a millimeter in wave-length) to near 80. All below 80, to the right, is the invisible infra-red spectrum. Now, the shaded curve above the spectrum represents the amount of energy in the sun's rays at the foot of the mountain, and was obtained in this way: Fix your attention for a moment on any single part of the spectrum; for instance, that whose wave-length is 60. If the heat in this ray, as represented by the bolometer at the foot of the mountain, was (let us suppose) 2°, on any arbitrary scale we draw a vertical line, two inches or two feet high, over that part of the spectrum. If the heat at another point, such as 40, were but $\frac{1}{5}$°, a line would be drawn there a quarter of an inch high; and so on, till these vertical lines mark out the shaded parts of the drawing, the gaps and depressions in whose outline correspond to the "cold bands" already spoken of. Again: if on top of the mountain we measure all these over once more, we shall find all are hotter; so that we must up there make all our lines higher, but *in very different proportions.* At 60, for instance, the heat (and light) may have grown from 2° to 3°, or increased one-half, while above 40 the heat (and light) may have grown from $\frac{1}{5}$° to 1°, or increased five times. These mountain measurements give another spectrum, the energies in each part of which are defined by the middle dotted line, which we see indicates very much greater energy, whether heat or light, in the blue end than below. Next, the light or heat which would be observed at the surface of the atmosphere is found in this way. If the mountain-top rises through one-half the absorbing mass of this terrestrial atmosphere (it does not quite do so, in fact), and by getting rid of that lower half the ray 60 has grown in brightness from 2 to 3, or half as much again, in going up to the top it would gain half as much more, or become $4\frac{1}{2}$; while the ray near 40, which has already increased to five times what it was, would increase five times more, or to 25. Each separate ray increasing thus nearly in some geocentric progression (though the heat, as a whole, does not), you see how we are able, by repeating this process at every point, to build up our outer or highest curve, which represents the light and heat at the surface of the atmosphere. These have grown out of all proportion at the blue end, as you see by the outer dotted curve, and now we have attained by actual measurement that evidence which we sought; and by thus reproducing the spectrum outside the atmosphere, and then recombining the colors by like methods to those you have seen on the screen, we finally get the true color of the sun, which tends, broadly speaking, to blue.

It is so seldom that the physical investigator meets any novel fact quite unawares, or finds any thing except that in the field where he is seeking, that he must count it an unusual experience to come unexpectedly on even the smallest discovery. This experience I had on one of the last days of work on the spectrum on the mountain. I was engaged in exploring that great invisible heat-region still but so partially known, or, rather, I was mapping in that great "dark continent" of the spectrum, and by the aid of the exquisite sky and the new instrument (the bolometer) found I could carry the survey farther than any had been before. I substituted the prism for the grating, and measured on in that unknown region till I had passed the Ultima Thule of previous travelers, and finally came to what seemed the very end of the invisible heat-spectrum, beyond what had previously been known. This was in itself a return for much trouble, and I was about rising from my task, when it occurred to me to advance the bolometer still farther; and I shall not forget the surprise and emotion with which I found new and unrecognized regions below—a new invisible spectrum beyond the farthest limits of the old one.

I will anticipate here by saying, that, after we got down to lower earth again, the explorations and mapping of this new region was continued. The amount of solar energy included in this new extension of the invisible region is much less than that of the visible spectrum; while its length upon the wave-length scale is equal to all that previously known visible and invisible, as you will see better by this view, having the same thing on the normal as well as the prismatic scale. If it be asked which of these is correct, the answer is, Both of them. Both, rightly interpreted, mean just the same thing; but in the lower one we can more conveniently compare the ground of the researches of others with these. These great gaps I was as first in doubt about; but more recent researches at Alleghany make is probable that they are caused by absorption in our own atmosphere, and not in that of the sun.

We would gladly have stayed longer, in spite of physical discomfort; but the formidable descent and the ensuing desert journey were before us, and certainly the reign of perpetual winter around us grew as hard to bear as the heats of the desert summer had been. On Sept. 10 we sent our instruments and the escort back by the former route, and, ourselves unencumbered, started on the adventurous descent of the eastern precipices by a downward climb, which, if successful, would carry us to the plains in a single day. I at least shall never forget that day, nor the scenery of more than Alpine grandeur which we passed in our descent, after first climbing by frozen lakes in the northern shadow of the great peak, till we crossed the east-

ern ridges, through a door so narrow that only one could pass it at a time, by clinging with hands and feet as he swung around the shoulder of the rocks, to find that he had passed in a single minute from the view of winter to summer, the prospect of the snowy peaks behind shut out, and instantly exchanged for that below of the glowing valley and the little oasis, where the tents of the lower camp were still pitched, the tents themselves invisible, but the oasis looking like a green scarf dropped on the broad floor of the desert. We climbed still downward by scenery unique in my recollection. This view of the ravine on the screen is little more than a memorandum made by one of the party in a few minutes' halt part way down, as we followed the ice-stream between the tremendous walls of the defile which rose two thousand feet, and between which we still descended, till, toward night, the ice-brook had grown into a mountain torrent, and, looking up the long vista of our day's descent, we saw it terminated by the peak of Whitney, once more lonely in the fading light of the upper sky.

This site, in some respects unequaled for a physical observatory, is likely, I am glad to say, to be utilized; the President of the United States having, on the proper representation of its value to science, ordered the reservation, for such purposes, of an area of a hundred square miles about and inclusive of Mount Whitney.

There is little more to add about the journey back to civilization, where we began to gather the results of our observation, and to reduce them; to smelt, so to speak, the metal from the ore we had brought home, a slow but necessary process, which has occupied a large part of two years. The results, stated in the broadest way, mean that the sun is blue, but mean a great deal more than that; this blueness in itself being, perhaps, a curious fact only, but, in what it implies, of practical moment. We deduce in connection with it a new value of the solar heat, so far altering the old estimates, that we now find it capable of melting a shell of ice sixty yards thick annually over the whole earth, or, what may seem more intelligible in its practical bearings, of exerting over one-horse power for each square yard of the normally exposed surface. We have studied the distribution of this heat in a spectrum whose limits on the normal scale our explorations have carried to an extent of rather more than twice what was previously known, and we have found that the total loss by absorption from the atmosphere is nearly double what has been heretofore supposed. We have found it probable that the human race owes its existence and preservation to the heat-storing action of the atmosphere even more than has been believed.

The direct determination of the effect of water-vapor in this did not come within our scope; but that the importance of the blanketing action of our atmospheric constituents has been in no way over-stated, may be inferred when I add that we have found by our experiments, that, if the planet were allowed to radiate freely into space, without any protecting veil, its sunlit surface would probably fall, even in the tropics, below the temperature of freezing mercury.

I will not go on enumerating the results of these investigations; but they all flow from the fact, which they in turn confirm, that this apparently limpid sea above our heads, and about us, is carrying on a wonderfully intricate work on the sunbeam, and on the heat returned from the soil, picking out selected parts in hundreds of places, sorting out incessantly at a task which would keep the sorting demons of Maxwell busy, and, as one result, changing the sunbeam on its way down to us in the way we have seen.

I have alluded to the practical utilities of these researches; but, practical or not, I hope we may feel that such facts as we have been considering about sunlight and the earth's atmosphere may be stones useful in the future edifice of science: and that, if not in our own hands, then in those of others when our day is over, they may find the best justification for the trouble of their search in the fact that they prove of use to man.

May I add an expression of my personal gratification in the opportunity with which you have honored me of bringing these researches before the Royal Institution, and my thanks for the kindness with which you have associated yourselves for an hour, in retrospect at least, with that climb toward the stars which we have made together, to find from light in its fullness what unsuspected agencies are at work to produce for us the light of common day.

ATMOSPHERIC ELECTRICITY.

By L. PALMIERI.

1. *Electricity with a Clear Sky.*—When within a circle of about 140 kilometers in radius, neither rain, snow, nor hail is falling, the electricity at the place of observation is always positive. If negative electricity is observed with a clear sky, downfall at some little distance may be inferred. As regards the daily periodicity of atmospheric electricity in calm, bright weather, two maxima and two minima may be recognized. The first maximum appears at the ninth hour of the morning; the second, which is more decided, a little after sunset. It often continues during a great part of the night. Toward daybreak a minimum appears, and a second, less distinct, in the afternoon. This daily period is easily disturbed by movements of the wind, by a cloud appearing on the horizon, by a mist rising from the somma, and by other causes often hard to determine. It may be asserted that when the maxima are very considerable, or when decided maxima appear at unusual times, the sky on the following days will scarcely be serene. If the sky begins to be overcast, the electric indications grow stronger, and if at the time of the evening maximum the relative moisture increases with a heavy dew, maxima of special intensity and duration may be expected. The general assumption that atmospheric electricity becomes stronger with the altitude has not been confirmed by the observations made simultaneously on Vesuvius and at the observatory of the University. The values obtained on Vesuvius were generally smaller. As regards the yearly periodicity, lower tensions are generally observed on hot summer days. In spring and autumn the indications are stronger. In winter the values are uncertain.

2. *Electricity with a Cloudy Sky.*—In the absence of distant rain, etc., the atmospheric electricity on cloudy days is always positive. It is less intense, more variable, and without a decided daily period.

3. *Electricity in Time of Rain.*—During rain, atmospheric electricity increases considerably, both at the place of observation and at some distance, even though no lightning occurs; this increase begins and disappears along with the rain. Sometimes, if rain is falling at a certain distance, the atmospheric electricity changes its sign once or repeatedly. When the rain is falling, the electricity is positive; this region is surrounded by zone of strongly negative electricity, upon which again follows a second zone of strongly positive electricity.

4. *Thunder-Rain.*—Between ordinary rain and thunder-rain, the only difference is the more abundant development of electricity in the latter. The raining cloud must be regarded as a constantly flowing source of electricity. There can be no lightning without rain and thunder. The so-called "harvest lightning" is merely a distant storm. The sound of thunder cannot be heard beyond 21 kilometers, while lightning is perceived at a far greater distance.—*Biedermann's Centralblatt.*

THE CIVET CAT.

THE CIVET CAT.

CIVET cats have a long tongue covered with horny papillæ, like that of the domestic cat, and slightly retractile claws, that is to say, capable of being drawn in so as not to be worn out while the animal is walking. These animals are divided into civet cats, properly so called, genets, and ichneumons.

The civet cat is about two feet in length. Its head is elongated, and its nose pointed. Its pupil contracts so as to form a transverse slit; its ears are short, erect, and of rounded form; its tail is long and cylindrical; and its fur is long, coarse, and grayish, variegated with black. The entire vertebral column is covered with coarse hair capable of erection. The animal has five toes to each foot, and retractile claws on the fore feet only. Beneath its tail it is provided with a pouch which contains an oily substance that hardens and furnishes a perfume analogous to musk, and which perfumers often substitute for that article on account of its being cheaper. This perfume is known in commerce as civet. It was formerly so fashionable among the Italians that the latter were styled "civet cats," just as in France we called dandies *muguets* ("lilies of the valley") when the perfume of the lily of the valley was popular; and the name civet cat has remained in the Italian language as a synonym for "coquette."

The perfume is extracted from the civet cat's pouch by means of a spoon. After this is done, butter is substituted for it. The animal is met with in Abyssinia, where it is very common, and in Spain, where it is very rare.

The genet is of the same shape as the civet, but it has no perfume pouch. It is found in Africa, in Spain, and even in France, where it is quite common in the Department of Gironde. It is often tamed, and it is known to the fur trade as the Spanish cat. Its fur is held in considerable estimation.

The ichneumon, which inhabits Egypt, is the same animal that the Egyptians adored under this name, because it destroys the eggs of the crocodile. Its fur is of a gray color.—*La Nature.*

TABLE OF CONTENTS.

85.

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